THE ENGINEERING CONSTRUCTION WEEKLY

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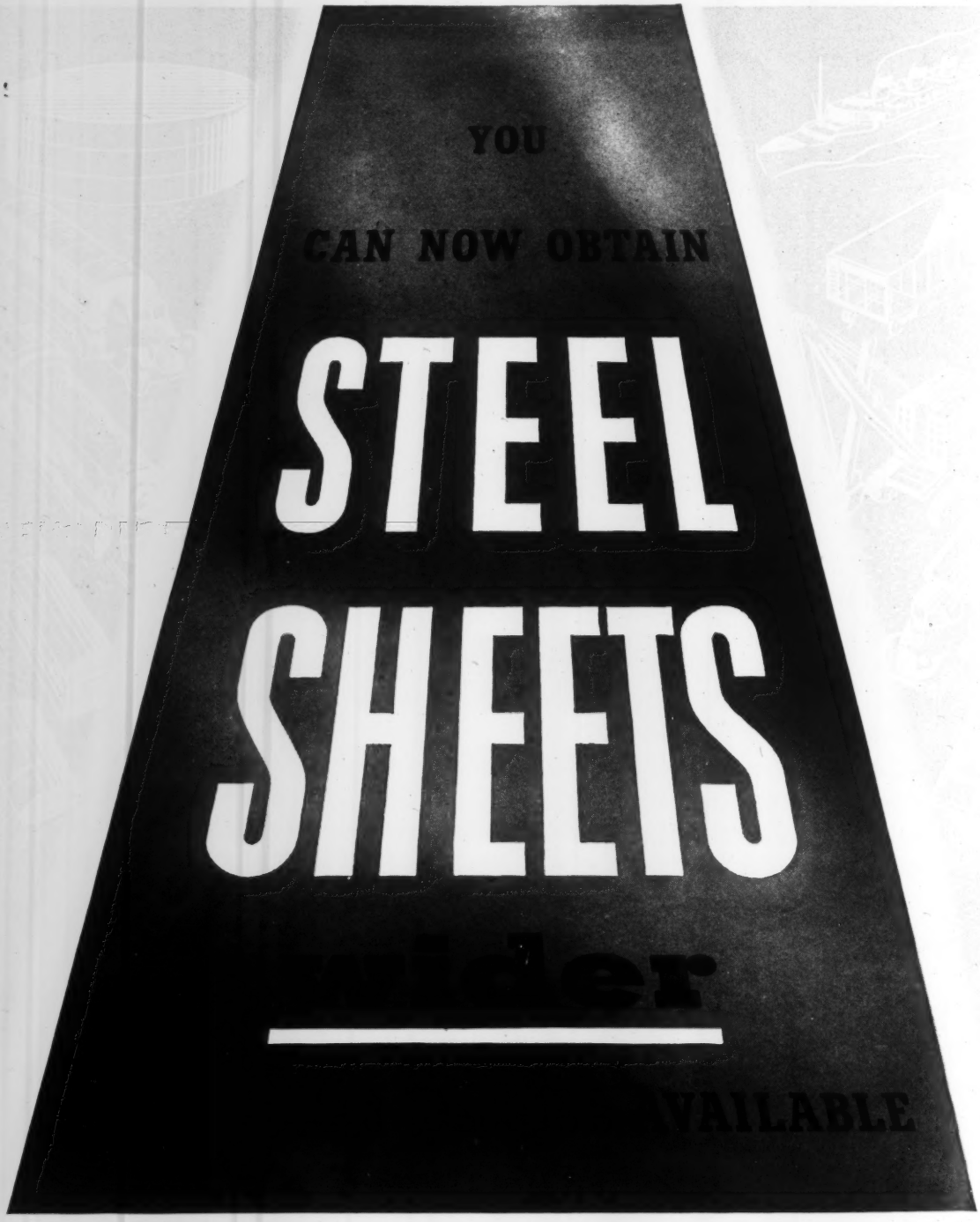

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McGRAW-HILL PUBLISHING COMPANY, INC.
WILLARD CHEVALIER, *Vice-President*
Editorial and Executive Offices: 330 West 42nd Street, New York . Publication Office: 99-129 North Broadway, Albany, N. Y.

F. E. SCHMITT, *Editor* ALBERT E. PAXTON, *Manager*

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VOL. 120 *MARCH 17, 1938* NO. 11

THIS WEEK AND NEXT

BRIDGE FLOOR DESIGN progress during the last ten years, as the port of New York Authority has seen it, is described by E. Warren Bowden, Assistant to the Chief Engineer.

Results of four years of studying the effects of sea water on various concretes are presented on page 400. The principal factors are density of mix and chemical composition of the cement, according to the findings.

Timber construction utilizes some rigid frame features in three storehouses for mill refuse fuel built by the Weyerhaeuser Timber Corporation in the Northwest. Included are built-up timber gusset plates.

Tensometers accurate to .00001 to .00002 in. per in., for use in strain rosette measurements, are described on page 404. Calibration of these instruments also presents problems, which are solved in these pages.

In 1876 an engineer stopped in Marshalltown, Iowa, and sold the city councilmen a waterworks, including rapid sand filters that provided only about 7 gal. per capita per day. The story of a 60-year development from this beginning to one of the finest plants in the Midwest is told in this issue.

A News-Record *editor sends back a page of observations on his trip west through Chicago to Denver.*

More-than-adequate road design for twenty years ago is decidedly obsolete now in many states. K. L. Rothermund tells how Ohio met this problem with limited funds.

NEXT WEEK—Erection of timber exposition buildings at San Francisco was accomplished by assembling large built-up panels.

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THE COVER PICTURE shows the present roadway and provision for future roadway on George Washington Bridge over the Hudson River at New York City. View looking eastward to New York.

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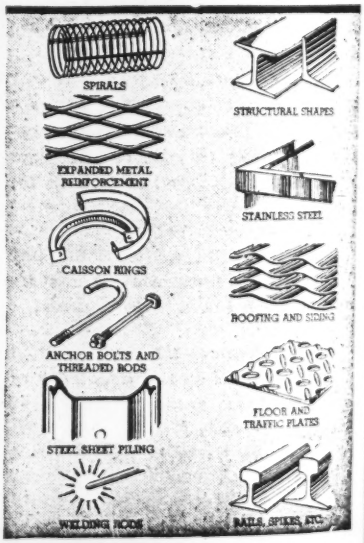

RYERSON STEEL-SERVICE

THE WEEK'S EVENTS

Dangerous Plumbing Found by Survey

More than two-thirds of fixtures in federal buildings found dangerous to health

A survey of plumbing fixtures in federaliy-owned buildings in New York City and Detroit has revealed that 67.7 per cent of the fixtures inspected in New York and 75 per cent of those in Detroit are of such a nature that "under certain conditions [they] may present a hazard to the public health." This is revealed in a report on Public Health Hazards in Plumbing produced as a result of a WPA survey which was sponsored by the U. S. Public Health Service.

The survey was begun at the instance of Representative Dingell of Michigan who, after the severe outbreak of amebic dysentery in Chicago in 1933, requested that the WPA and the U. S. Public Health Service make a survey of plumbing in federal buildings; it was felt that this would give an indication of conditions existing in buildings generally.

Survey restricted

Because of the difficulty of obtaining sufficient personnel for such a broad survey, it was restricted to federal buildings in New York and Detroit. The field inspection groups were composed largely of recent graduates in sanitary or allied engineering courses. They were given a four weeks training course at New York University on the technique of plumbing inspection.

In New York City 21,928 fixtures in federal buildings were inspected and 2,736 fixtures were inspected in Detroit. The number of fixtures listed as "disapproved, with the term "disapproved" used "to denote those fixtures which fall in the category of plumbing installations which, under certain conditions, may present a hazard to the public health," was 14,844 for New York City and 2,052 for Detroit.

All hazards counted

In the survey no cognizance was taken of the fact that conditions necessary for the spread of contamination varied in the different buildings inspected; the presence of a definite path by which contamination possibly could be spread was the sole basis for approval or disapproval.

An analysis of the fixtures examined according to type of building and type of fixture indicated that the percentages of disapproval were very nearly the same in Detroit and New York and the report concludes that "as defects were found in the New York buildings in about the same numbers as in Detroit buildings, it can be concluded that the same conditions exist in federal buildings in all other cities. Also it seems reasonable to conclude that similar conditions will be found in other public buildings generally."

• • •

General Markham Honored

Edward M. Markham, retired Chief of Engineers, U. S. Army, who was recently appointed commissioner of public works of the city of New York, was the guest of honor at a dinner given on March 8 by members of the Metropolitan Section, American Society of Civil Engineers. Other guests included Mayor La Guardia. The position of commissioner of public works is a new one created under the new city charter that went into effect at the first of the year. Direction of all construction work of the city except that covered by local assessments is centered in the office of the commissioner of public works.

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Senator Norris Agrees To TVA Probe

Arthur Morgan refuses to amplify charges against other directors before the President

A Congressional inquiry into Tennessee Valley Authority affairs was assured as Senator Norris, abandoning hope of having the investigation made by the Federal Trade Commission, acceded this week to the demand that Congress look into TVA affairs.

The decision was made after President Roosevelt, in an all-day session with the three TVA directors, failed to elicit from Chairman Arthur E. Morgan specific facts bearing out his general charges against the conduct of his two colleagues (*ENR*, Feb. 10, 1938, p. 352). The following points are abstracted from the transcript:

President Roosevelt: ". . . The gist of your complaint also appears to be contained in your Berry Claims statement that: 'the real difficulty has been in the effort to secure honest openness, decency and fairness in government. The Berry case, as I have said, is an instance of this difficulty'. . . . I must, therefore, ask you what evidence of dishonesty or malfeasance on the part of your colleagues you have . . . ?"

Arthur E. Morgan: "During a long period, I have repeatedly but unsuccessfully endeavored to secure the President's adequate consideration of grave conditions within the TVA. The most recent occasion was last fall . . . when I personally presented to the President a draft of a letter which I asked him to send to the TVA board. This letter requested the board to make available to me the data and assistance necessary for me to make a report to the President concerning the conditions I had criticized. The President did not grant that request and made no alternative suggestions. I am of the opinion that this meeting is not, and in the nature of the case cannot be, an effective or useful fact-finding occasion."

The President: "Wait a minute. I don't want opinions. I want facts. I have asked you a question about the Berry marble case, and I want you to confine your answers . . . to facts."

A. E. Morgan: "I wish to complete

Wide World Photo

ENR Staff Photo

TVA DIRECTORS AT WHITE HOUSE

THESE THREE TVA directors were summoned by the President March 11. Shown as they entered the White House are: H. A. Morgan (*left*), David E. Lilienthal (*center*), and chairman A. E. Morgan (*right*).

my statement, which will take about a minute longer."

The President: "I don't want you in any statements to talk about opinions. I want you to confine yourself to facts."

A. E. Morgan: "I am giving my reasons for not answering you directly and I think I must do it."

The President: "Are you planning to answer the direct question?"

A. E. Morgan: "My statement will indicate whether I am or not. I am of the opinion that this meeting is not, and in the nature of the case cannot be, an effective or useful fact-finding occasion. To properly substantiate the charges is not the work of a morning. Since the Congress has taken up the matter—"

The President: "Have you any reason to believe this will be confined to a morning?"

A. E. Morgan: "Since the Congress has now taken—"

The President: "Have you any reason to believe that this hearing will be confined to a morning?"

A. E. Morgan: "I should like to complete my statement, if I may, without interruption. Since the Congress has now taken up the matter, I believe that any report by me should, in the terms of the TVA Act, be filed with the President and with the Congress. It is my studied judgment that the President, the Congress and the people of this country are entitled to accurate information and appraisal of the program, policies, administration and activities of the authority. Such information and appraisal can best be obtained and made available to the people, to Congress and to the President by a Congressional committee which will make an impartial, comprehensive and complete investigation of the authority's affairs."

Having made this statement the Chairman declined to amplify his charges relating to the conduct of the Berry condemnation. The President then asked H. A. Morgan and Lilienthal if they had any answer to the general charge. H. A. Morgan then gave a long and detailed account of the conduct of the board in the Berry matter, emphasizing that the board had no evidence of bad faith on the part of the claimants until the eve of the condemnation trial. Then came the following interchange:

The President (addressing A. E. Morgan): "Reverting to the statement you first made, . . . A few days after you saw me in September I told Dr. Harcourt A. Morgan that you wanted the facts, that you wanted data and necessary assistance to make a report. Dr. Morgan told me that you had full authority to get any data you wanted from any of the files of the TVA and that at no time had the majority members of the board withheld any information from you, from those files or records."

A. E. Morgan: "That statement is not correct but I will answer it at the proper time—that statement by Dr. Morgan and not yourself."

Similar results followed when the President took up, one by one, the other general charges which A. E. Morgan has made. In each case the Chairman refused to go beyond his original statement, while the other two board members presented detailed and documented rebuttal of the charges, except in one or two instances when they pleaded inability to answer without further specification by the Chairman, which was refused.

The meeting then considered charges which the majority of the Board had made against Chairman Morgan. One by one, these were brought up and supported by specifications presented by H. A. Morgan or Mr. Lilienthal, or both. Chairman Morgan, in general, continued his attitude of being a spectator rather than a participant.

It was brought out that these charges were based upon several actions of A. E. Morgan in connection with the 18-utility company attack upon TVA constitutionality, the negotiations for the purchase of Fontana dam site, and the valuation, for power purposes, of Wilson Dam. The charges were extremely involved and, in general, accused the Chairman of following independent lines of action not in conformity with decisions made by the majority of the board. Except to characterize the statements as containing "striking and vital inaccuracies, misrepresentations, and omissions" A. E. Morgan refused to amplify his original statement.

At the conclusion of the six-hour meeting, the President declared that it would be resumed a week later, on March 18. He demanded that any director who could not cooperate in carrying out board decisions resign.

THE CURRENT TREND

This week's news of contract volume and construction cost factors

Construction Recovery Advances

Construction activity gains while general business and manufacturing indices sag

Accumulating momentum of construction in January and February, as reported by *Engineering News-Record*, has placed the construction industry out in front in the recovery picture. To measure this recovery, dollar volume of construction, based on 1929 as 100, climbed to 69.8 in February, an increase of 31 per cent over December, 1937, and 125 per cent over the 1932 average. Physical volume of construction as measured by *ENR* Construction Volume Index, also compared with 1929, is 59.0 for February, an increase of 33 per cent over December, 1937, and 47 per cent above the 1932 average.

The general business index compiled by Business Week stands at 55.3 for February, based on 1929 as 100, a decrease from 59.0 in January, and 59.9 in December, 1937.

Manufacturing activity as reported by the Federal Reserve Board index is 63.9 for January, also based on 1929 as 100, a drop of 4 per cent from the 66.3 value for December. The current recession in manufacturing activity began its decline last spring from its peak of 101. The average for 1937 was 91.5.

Compared with 1937 rate of activity, construction recovery shows an even more favorable position: a gain for construction of 27 points in dollar value and of 26 points in physical volume, while the general business index dropped 6 points and manufacturing 2 points.

This is the first time since the depression that construction has taken so favorable a position in the recovery movement. The current gain is widely distributed, with highway construction well ahead of a year ago and large housing and apartment projects getting under way. More lettings have been scheduled for January and February this year than in any of the preceding four years, and the volume of proposed work is heavy.

Building Permits

Building permit volume for February, $54,065,213, is 63.2 per cent below January and 37 per cent below February, 1937. Falling off in permit values in New York City, following the high volume due to the rush to file before new building code went into effect, is responsible for the decline from last month. The volume for the 214 other Dun and Bradstreet cities is 17.6 per cent above January.

Cumulative value of permits is $200,931,338 for the two months of 1938, 30.2 per cent above the $154,341,654 reported in 1937, and the highest total for any corresponding period since 1930.

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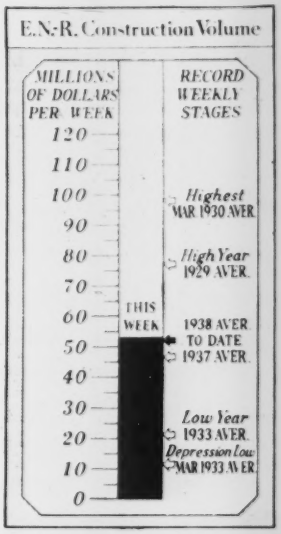
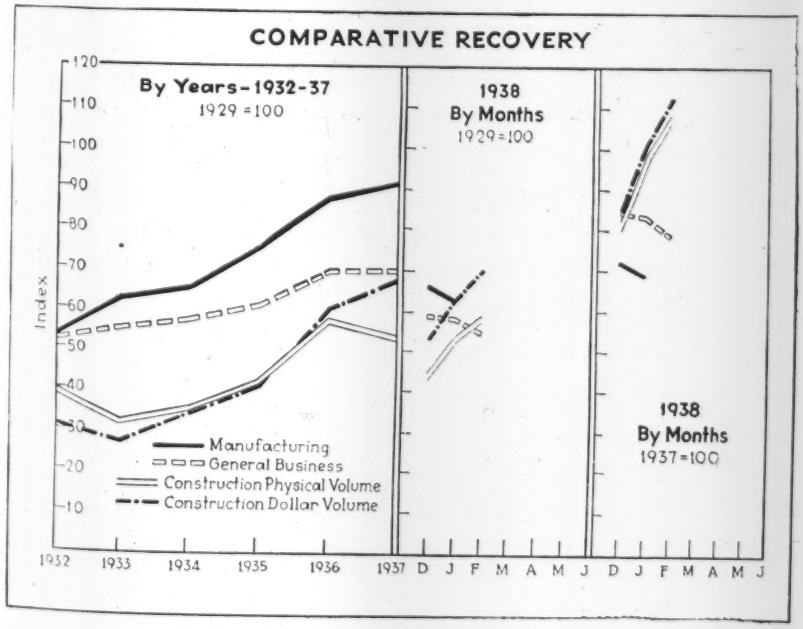
AMERICAN APPRAISAL COMPANY construction cost index at 183 for January, 1938, is 1 point, or 0.5 per cent, below the December index. Lower lumber prices responsible for decrease.





THIS WEEK'S FIGURES

(Thousands of Dollars)

CONTRACTS

	Week Ending Mar. 18 1937	Mar. 10 1938	Mar. 17 1938
Federal	$5,340	$4,006	$5,904
State & Municipal	11,304	18,616	26,810
Total public	$16,644	$22,622	$32,714
Total private	17,925	57,902	20,570
TOTALS	$34,569	$80,524	$53,284

Cumulative
1938 (11 weeks) $575,027
1937 (11 weeks) $470,056

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1937 11 Wk.	1938 11 Wk.
NON-FEDERAL	$348,463	$337,605
State & mun. bonds	134,752	187,368†
Corporate securities	167,142	90,364
PWA loans, grants	46,562	—2,497†
RFC loans	7	62,370
FEDERAL		
TOTAL CAPITAL	$348,463	$337,605

† Represents transfer from federal to private investment financing through sale by RFC of PWA bonds.

EN-R INDEX NUMBERS

Index Base	1913	1926
Construction Cost (Mar.)	243.39	117.00
Construction Volume (Feb.)	187	82

California Flood Area Approaching Normal

Flood works now totally unprepared to handle any new flood conditions which might arise

Reliable specific information is not yet available on the amount of damage done by the flood of March 2-5 in which streams in the Los Angeles basin recorded record discharges after storms bringing as much as 30 in. of rainfall to the watershed.

Telephone and telegraph are now operating normally in most areas. Rail and highway traffic is moving on main routes through the lowland area as fills are replaced and temporary structures supplant washed out bridges. Secondary routes, which, because of their lower standards of construction, were the principal sufferers, are still closed for the most part; most mountain highways also are still not open to travel.

Repair funds

The state highway department has $1,000,000 available for emergency repairs; the cost of such repairs is placed by a first estimate at $2,700,000. Permanent replacements will have to await more funds. It is planned to postpone new construction until the needed funds are obtained. The state legislature, now in special session, is expected to appropriate other money from the state emergency fund or possibly from an added gasoline tax.

So far no evidences of water borne diseases have manifested themselves. The water supply, however, in some districts of Los Angeles and in a number of suburban cities is open to possible pollution from broken sewer systems, and health authorities advocate boiling of drinking water.

Flood danger

Another big storm would produce critical conditions, since the flood control system is now largely unavailable, and the channels would have to handle an unregulated flow largely unaided by the debris basins and mountain reservoirs.

Most of the Los Angeles County Flood Control District's regulating reservoirs in the San Gabriel mountains are either filled with debris or their outlet works are so clogged with silt and trash as to render reduction of the reservoir stage difficult. The sixteen debris basins, largely in the area above Montrose, functioned well but are now mostly inoperative, since of their 800,000 cu.yd. capacity about 700,000 cu.yd. is already occupied by debris. Immediate removal of the material is prevented by its saturated condition.

The debris deposited in reservoirs and debris basins amounted to from 30,000 to 50,000 cu.yd. per square mile of drainage area.

The San Gabriel River system is handicapped because the incomplete state of construction of the outlet works of the high San Gabriel Dam makes it impossible to release water from the reservoir. During the flood, the Morris Dam of the Pasadena water department was operated in conjunction with the San Gabriel flood control dam, and the system reduced the flood peak in the stream from 100,000 (previous high 40,000 in January, 1916) to 35,000 sec.-ft.

It was also found possible to time the flood peak so that the more than half of the flow which took the Rio Honzo channel from the San Gabriel River to the Los Angeles River arrived at a different time from the flood crest of the upper Los Angeles, and the maximum discharge was held to 102,000 sec.-ft. (previous high, 38,000 in December, 1889).

Photo by J. D. Jacobs

OUT TO KEEP A MID-RIVER DATE

FIRST of four shields that will drive the double-tube Queens Midtown Tunnel under East River in New York started on its way from the Manhattan approach late last month. This view shows the south tunnel shield ready for its first shove; the north tunnel shield has been erected and is ready for shoving. Both will meet two more shields starting from the Queens side in mid-river. The Queens approaches are still in good rock, so shield erection has not yet been started on that side. Walsh Construction Co. is driving the tunnels for the New York Tunnel Authority.

Three Millions Available For Flood-Damaged Roads

The Bureau of Public Roads has emergency funds available that can be used for rehabilitating federal-aid highways damaged by the recent Southern California floods, according to Thomas H. MacDonald, director of the bureau. This has already been drawn upon by California to the extent of $741,265 caused by floods in December, but $3,114,000 remains in the fund. The fund was set up under the Hayden-Cartwright Act of 1934 for emergency repairs to federal-aid highways.

Sen. McAdoo of California has introduced a joint resolution authorizing WPA to spend $25,000,000 in the flood area to cover the relief of flood sufferers, repair of public works, and debris removal from public and private property.

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Show-Cause Order Granted To Discharged Engineer

The common pleas court of Franklin County, Ohio, on March 8 ordered Ohio highway director Jaster to show cause why he should not restore Harry A. Sparks to the position of bituminous engineer in the state highway department from which he was discharged by the abolition of the position May 3 (*ENR*, March 10, 1938, p. 353).

Mr. Sparks has brought suit seeking to obtain reinstatement in his position. He charges that the highway director abolished the position at the direction of Governor Davey "without definite cause or reason." Mr. Sparks explains that he was summoned before the recent Senate investigating committee to testify concerning the letting of highway paving contracts. Because of his testimony he charges Governor Davey became angered "at the truthful revelations" made by him "of the condition of affairs in the highway department," and stated in a public address that Sparks would be discharged for answering the Senate committee questions in the way he did.

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Quebec Plans Program Of Road Construction

The government of the province of Quebec has announced that it will introduce legislation at the present session of the provincial legislature empowering the government to raise the sum of $50,000,000 for a four-year road program. This road construction work will be in addition to the regular maintenance and extension work which is now carried out each year from current revenue.

LABOR NOTES

BUILDING construction in Seattle, Wash., has been at a standstill since March 7, the deadline for demands of contractors there that work be done on an 8-hr. day basis (*ENR* Feb. 17, 1938, p. 253). The unions have refused to relinquish the 6-hr. day, which has been standard for Seattle for the past year under a contract which expired Feb. 1.

ALL THE UNION MEN employed by Isaac Penner, New York City electrical contractor, were laid off March 11, the contractor announced. He will replace them with non-union men. Mr. Penner, whose firm has city and state contracts totaling $223,000, accused Local 3 of the International Brotherhood of Electrical Workers of "sabotage, discrimination and racketeering." He said that the union was cooperating with a group of contractors engaged in submitting collusive bids and was harrassing those who refused to "play along."

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Former Buffalo Mayor Charged with Sewer Fraud

John G. Zimmerman has been indicted by a grand jury on bribery charges in connection with the $15,000,000 Buffalo sewer project. Mr. Zimmerman, who was formerly mayor of Buffalo, has pleaded innocent.

It is charged that Mr. Zimmerman attempted to collect funds from a candidate for the post of consulting engineer on the project, that he promised a reward to a member of the sewer authority in return for his vote, and that he collected various sums of money for using his influence to give the sewer bonding to a Buffalo firm.

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Big Cement Contract Let For Marshall Ford

Contracts covering 750,000 barrels of low-heat portland cement for Marshall Ford Dam at a total cost to the government of $1,399,600 were awarded March 7 to two Texas companies. Bids were competitive.

The Longhorn Portland Cement Co. of San Antonio offered to furnish 375,000 barrels at a net delivered cost of $1.73 per barrel, while the Trinity Portland Cement Co. of Dallas offered to furnish the entire amount at a net cost of $1.91 per barrel, or any amount less than 500,000 barrels at a net delivered cost of $1.97 per barrel.

To receive the lowest price under which the required monthly delivery of 85,000 barrels could be obtained, the Longhorn Portland Cement Co. was awarded a contract for 410,000 barrels and the Trinity Portland Cement Co. for 340,000 barrels at a net cost of $1.97 per barrel.

• • •

Ambursen Allowed Claim For Changed Plan

The U. S. Court of Claims in a decision handed down March 7 held that the Ahbursen Dam Co. should be paid on a cost-pluss-profit basis for placing classes of concrete not covered in specifications.

The case arose out of a contract of the Ambursen Dam Co. for construction of the Stony Gorge Dam of the Orland irrigation project in California. Various classes of concrete were provided for in the contract at different prices depending not so much on the composition of the concrete as upon the extent to which forms would be required in laying it. Material alterations were made in the layout work which resulted in some concrete being laid in a manner different from any of the classes named in the specifications.

On such concrete the Court of Claims held that the conditions had been changed so materially as to make the specifications inapplicable, and the court judged that the contractor was entitled to be paid for such concrete on the cost-plus basis.

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WPA Highway Program Approved for Jersey

The President has approved a $25,000,000 WPA highway improvement program for the state of New Jersey. The program, which is expected to provide about 20,000 man-years of work, will be financed by WPA contribution of about $20,000,000 and a $5,000,000 contribution by the sponsor. In addition, the state will provide $1,800,000 for purchase of rights-of-way. Of the $5,000,000 furnished by the state, $3,800,000 will be used for purchase of materials.

The program will cover construction of new highways in the state primary road system as well as widening and improving the drainage system of existing primary highways. Secondary highways and state-aid roads are to be improved by construction of new shoulders and additional drainage facilities and by realignment.

A part of the program also provides for construction of new roads within the grounds of various state institutions for which the state highway department is responsible.

Railway Consultant Dies at Seventy

Frederic A. Molitor had practiced in New York City since 1908, decorated for war service

Frederic A. Molitor, widely known railway consultant, died after a long illness in Stamford, Conn., on March 12 at the age of 70.

Col. Molitor graduated from Cornell University in 1886 and entered the engineering staff of the Central Ry. of New Jersey as a draftsman. He left the Jersey Central as chief draftsman and became assistant engineer for the Baltimore & Ohio, working on construction of the Kill van Kull bridge at Staten Island. Later, on the engineering staff of the Chesapeake & Ohio, he was engaged in construction of its bridge at Cincinnati. In 1898, as engineer of the shipping department and river and harbor terminals of the Philadelphia & Reading, he had charge of construction of the coal terminal at Port Richmond, Philadelphia.

After service as engineer in charge of construction of the Montauk extension of the Long Island R.R., he became chief engineer of the Choctaw, Oklahoma and Gulf R.R. and its allied companies; in this capacity he had charge of location and construction of more than a thousand miles of railroad.

Col. Molitor then surveyed and built the 350-mile Midland Valley R.R. of which he was general manager and chief engineer for some years.

In 1905 Col. Molitor was appointed railroad expert to the Philippines, where he succeeded John F. Stevens. Then after a year of travel in the Orient and in Europe studying railroad conditions and terminal problems, he entered private practice in New York City in 1908.

In the course of his practice, Col. Molitor was chairman of the Board of Economics and Engineering, National Association of Owners of Railroad Securities, a member of the special Panama Canal Committee, consulting engineer of the board of the Hudson River Regulating District, and chairman of the Committee of Valuation of Damages, National Railways of Mexico.

He served during the war as a major in the Engineer Reserves, was promoted to colonel in 1918, and went overseas with the 27th Engineers. He was later detached from his regiment as officer in charge of engineering supplies. He was cited by General Pershing for distinguished and meritorious services and received the award of L'Etoile Noire from France.

Six Year Plan Made For Water Control

National Resources Committee recommends $200,000,000 per year for water control structures

A six year program of investigation and construction for use and conservation of the water resources of the country is recommended in a report of the National Resources Committee transmitted to Congress last week by President Roosevelt. The report is a revision and extension of the program recommended by the committee in 1937.

The revised report includes lists of primarily federal projects for a six-year period with a total cost of $891,091,000. This is about equal to the expenditure for water control projects during the last six years; it would provide for a weighted average expenditure per year of $200,624,000.

The types of work included in the recommended list of specific projects for the next six years is indicated in the table below.

These projects are intended to be carried out primarily with federal funds with some local contributions. However, the report presents a summary of recommended construction for water supply and sewerage during the next six years which would be primarily non-federal. This would call for construction of 2,678 water supply projects costing $566,765,000 and 3,484 pollution abatement and sewerage projects costing $667,011,000. This would give an annual average cost for these types of construction not varying greatly from the 1925-1936 average annual expenditure of $161,000,000 for waterworks and $129,000,000 for sewerage.

The report was prepared by the Water Resources Committee of the National Resources Committee. Non-governmental members of the Water Resources Committee are Abel Wolman, chairman, chief engineer of the Maryland State Department of Health; H. H. Barrows of the University of Chicago; Edward Hyatt, state engineer of California; Thorndike Saville, dean of the College of Engineering of New York University. Governmental members of the committee are Bushrod W. Allin, Office of Land Use Coordination, Department of Agriculture; Milton S. Eisenhower, coordinator of land use planning, Department of Agriculture; N. C. Grover, chief hydraulic engineer, Geological Survey; Roger B. McWhorter, chief engineer, Federal Power Commission; John C. Page, commissioner of the Bureau of Reclamation; Major General Julian L. Schley, Chief of Engineers, U. S. Army; R. E. Tarbett, senior sanitary engineer, U. S. Public Health Service; and Sherman M. Woodward, chief water control planning engineer, Tennessee Valley Authority.

The present report is based on the reports of 45 regional drainage basins committees and merely summarizes the specific problems in various regions of the country. The report of the drainage basin committees will be published in full later.

1937 progress

The National Resources Committee finds that during the past year little progress has been made in the compilation of basic hydrologic data. Deficiencies in data and a program for their removal have been set forth, but little has been done toward accelerating the collection and analysis of facts.

"Some progress" is reported toward the development of an integrated national water policy. The flood control act of 1936 has special significance in that it declares flood control on navigable waters and their tributaries to be a proper activity of the federal government, and the Overton act for the first time authorizes reservoirs as elements in the flood control plans for the lower Mississippi. Amendments to the flood control act made in 1937 empowered the Secretary of Agriculture to require as a condition for federal benefits that state and local laws impose suitable restrictions on the use of protected lands. The Connecticut and Merrimack Valley interstate compacts were ratified by the states concerned but not approved by Congress.

The states of Arkansas, Louisiana, Mississippi, Illinois, New York, Pennsylvania, Idaho and Washington, during 1936-37, either created special commissions or designated a state agency to carry out measures for flood control and protection on rivers of the state, and state legislation for flood control districts was passed by Louisiana, Maryland, Massachusetts, New Hampshire, Pennsylvania and Texas.

Stream pollution

Both houses of Congress passed stream pollution bills during 1937, and a conference is attempting to reconcile the two bills, which differ widely. The Rivers and Harbors Act of 1937 authorized the War Department to study the pollution of the Ohio River, and the Pennsylvania state legislature passed the LaRue bill forbidding pollution of state waters except as permitted by the Sanitary Water Board.

Passage by Congress of the McNary-Mansfield bill provided that the Bonneville project be operated by the War Department and power be sold by an administrator.

Chief changes in irrigation policy during the year are the passage of laws restricting land speculation in the Grand Coulee project area and the appointment of a commission to study repayment procedure.

Passage of the Federal Beach Protection Act in 1936 gave to the federal government partial responsibility for the control of beach erosion.

FEDERAL WORKS PLAN PROPOSED BY RESOURCES COMMITTEE

Class of Work		Investigation	Construction	Total
Flood Control: Ohio and Lower Mississippi	2-year	$15,850,000	$65,416,000	$81,266,000
TVA program	2-year	1,722,000	73,339,000	75,061,000
General flood control	6-year	7,000,000	177,629,000	184,629,000
Irrigation	6-year	3,587,000	287,952,000	291,539,000
Water power	6-year	3,650,000	See note	3,650,000
Rivers and harbors	6-year	1,750,000	178,825,000	180,575,000
Rural water supply	6-year	.....	33,495,000	33,495,000
Beach erosion control	6-year	617,000	13,782,000	14,399,000
Recreational waters	6-year	139,000	5,019,000	5,158,000
Wildlife conservation	6-year	270,000	8,253,000	8,523,000
Hydrologic data	6-year	12,796,000	.....	12,796,000
Totals		47,381,000	843,710,000	891,091,000
Weighted average per year		13,754,000	186,870,000	200,624,000

Construction of water-power projects is included in other items according to the construction agency or other purposes served by the multiple-purpose structure involved.

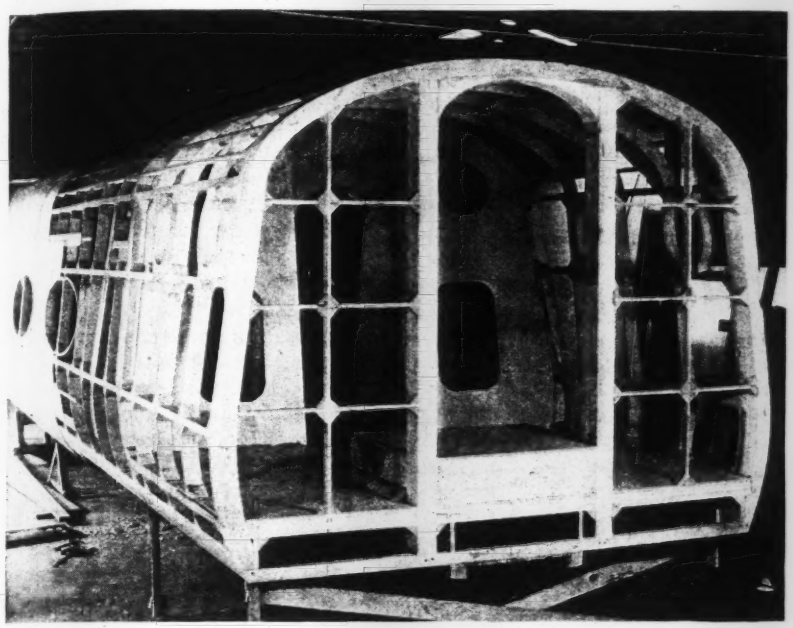
• • •

All Housing Money To Be Earmarked

Nathan Straus, U. S. Housing Authority administrator, has announced that the process of "earmarking," by which stated sums are tentatively reserved for specific cities pending the approval of detailed plans, will be expanded to include the entire $500,000,000 authorized under the act. This will enable cities participating in the program to base their plans upon a full three-year program.

Hitherto the limit has been a total of $300,000,000, with not more than $30,000,000 for any one state. These are the amounts that can actually be expended before July 1, 1939. Mr. Straus explained that physical limitation will make it impossible to pile up obligations exceeding these limits even though much larger amounts may be earmarked in the near future.

Earmarkings to date total $168,445,000 for 50 cities in 19 states. In three states—New York, Pennsylvania, and Ohio—the $30,000,000 limitation is already preventing the consideration of additional meritorious projects, but this embarrassment is removed.



SPRING-MOUNTED SKIN-STRESSED RAILWAY CAR

Incorporating a novel spring mounted body and employing the monocoque or stressed skin principle commonly used in airplane design, an experimental two-car train of unusual design has recently undergone successful test runs in California. The project is sponsored by Cortland T. Hill, son of the retired chairman of the board of the Great Northern Ry.

The cars are connected to the trucks by soft coil springs. Pedestals or towers protrude upward from the trucks into the car body to a level above the center of gravity of the body. Coil springs and lateral control arms are mounted on top of these towers and the car body hangs from the top of the spring. A passageway goes between the towers.

Bodies of the experimental unit are made entirely of wood to reduce the cost and time of construction of the model. It was so designed that the outer covering or skin is used as a principal load carrying element.

Shown above is the full-scale model under construction. Load reactions from the trucks are transferred to the transverse bulkheads shown inside the body with inspection holes in them.

Oklahoma City Water Plan Rejected Second Time

Voters of Oklahoma City, Okla. on March 12 voted down a proposed $2,357,000 bond issue which would have enabled the city to participate in the Fort Supply reservoir project. This was the second time that the issue had been voted upon; the bond issue was rejected by a narrow vote Dec. 7 (*ENR*, Dec. 16, 1937, p. 964). On the second occasion the defeat was more decisive, complete unofficial returns showing 8,846 in favor and 10,058 against as compared with a vote of 10,891 for the bond issue and 9,303 against in December. A 60 per cent vote is necessary for approval.

The Fort Supply Dam is on Wolf Creek, a tributary of the North Canadian River about 135 miles from Oklahoma City. It will be an earth dam with an uncontrolled concrete spillway and a regulating discharge conduit.

The dam is being built by the federal government at a total cost of $5,000,000. If the city had voted to participate, an additional 100,000 acre-ft. would have been added to the capacity of the reservoir and used as a water supply for the city.

• • •

Technical Teachers Course In New York State

The New York State educational department is soon to start a course for graduate professional engineers who wish to become instructors in technical subjects in vocational and technical high schools.

Candidates for the courses must have completed a four year college course in architecture, engineering or applied science, must have at least three years experience in the technical field and be between the ages of 21 and 35. The teacher training courses will lead to certification of the candidates by the state.

WASHINGTON HIGHLIGHTS

Special reports by Paul Wooton

REP. BEITER of New York has introduced a bill to extend the life of the Public Works Administration to January 1, 1941 and to permit the use of social security funds for loans on public works projects, including $750,000,000 for allotments to executive departments or to PWA, and $50,000,000 for new buildings in the District of Columbia to house the Social Security Board, the War and Navy Departments, and the General Accounting Office.

PROBLEMS relating to international water questions on the Colorado River and Rio Grande were discussed March 10 at a meeting of Western Senators attended by Secretary of State Cordell Hull. It is understood that the discussion was in preparation for a possible treaty with Mexico dealing with the allocation of international waters between the two countries.

CONGRESS has passed a bill authorizing the city of Rock Island, Ill., to construct, maintain and operate a toll bridge across the Mississippi River between Rock Island and Davenport, Iowa.

THE I.C.C. on March 10 authorized the Chesapeake and Ohio R.R. Co. to construct and operate 9.75 miles of branch lines in Boone County, West Virginia.

• • •

Pennsylvania Turnpike Bonds Are Sold

The Pennsylvania Turnpike Commission which was set up by the state legislature last year to build a 155-mile superhighway from Harrisburg to Pittsburgh making use of the roadbed and tunnels of the old South Penn R.R., sold $60,000,000 of revenue bonds to a banking syndicate March 10. The South Penn R.R. was put under construction during the last century; much grading was done and several tunnels were built, but the line was never finished.

The bonds, which carry 3½ per cent interest, are not general obligations of the commonwealth but will be secured by tolls on the proposed road. The syndicate is expected to offer the bonds to the general public in the near future.

(News continued on page 415)

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Cracks in Housing Project Walls

Sir: News items in Engineering News-Record (Dec. 30, 1937, p. 1039 and Jan. 13, 1938, p. 43) have referred to cracks in the walls of the Lockfield Garden PWA housing project in Indianapolis. The accompanying illustration shows this cracking, which occurs at the corners and at the slab line and is due to expansion and contraction of the concrete slabs which rest on load bearing walls, constructed of 4-in. face brick and 8-in. haydite block backing.

The condition portrayed is typical of all 24 buildings on this project, both as to cleavage at the slab lines and as to cracking at the corners. The cracking is most severe at the roof slab line and progressively becomes less for each of the lower floor slabs.

It is also typical, to a greater or lesser degree, of many hundreds of buildings on most other housing projects of this type—we have examined 37 projects throughout the country—among them being Hillcreek at Philadelphia; Dixie Homes at Memphis, Tenn.; Lauderdale at Memphis, Tenn. (slab type buildings only); Logan Fontenelle Homes, Omaha, Neb.; Westfield Acres, Camden, N. J.; Highland Homes, Wayne, Pa.; Grand Whitlock, Toledo; and Trumbull Park, Julia C. Lathrop, and Jane Addams Homes at Chicago.

On some of these projects the cracking is very severe. On some corners we have examined on these other projects it was found that movement had pushed the parapets to such an extent that they overhung the rest of the wall from ¾ to 1 in.

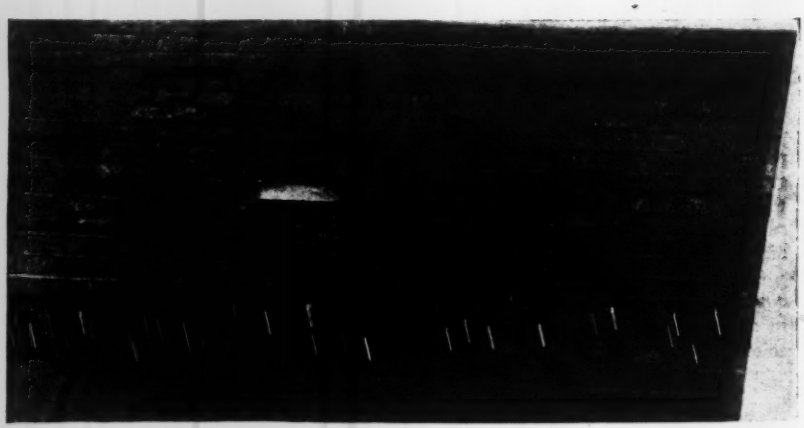
The slabs on the Indianapolis project were generally poured in one integral unit and would average about 27 ft. wide by 150 ft. long by 5½ in. thick. The main reinforcing steel consists of ½-in. rounds, 6 in. on centers, with temperature steel of ⅜-in. rounds, 12 in. on centers. The concrete is 1:2.5:3.3, mechanically vibrated and has a 7-day strength of approximately 3000 lb.

B. J. MYREN
N. P. Severin Co., Chicago, Ill.

High-Strength Reinforcing

Sir: A. S. Macdonald of Sydney, Australia, in his letter (*ENR*, Dec. 16, 1938, p. 970) submits five alleged objections to the 50 per cent higher unit stress that is allowed for cold-twisted twin reinforcing bars in the new building code of the City of New York as compared with the allowable unit stress for ordinary structural grade reinforcing bars.

Having given considerable study to this subject, I do not believe that Mr. Macdonald's objections are valid and I wish to offer my comments on them.



Crack in wall at roof slab level, typical of condition on a large number of PWA housing projects.

1. He suggests that in long buildings without contraction joints, the natural contraction of the concrete at construction joints is liable to fracture reinforcement which has had its capacity for local elongation removed by twisting. In reply, it should be observed that the capacity for local elongation is not removed by the cold twisting; all the capacity for local elongation that is desirable is retained. Moreover, the local yield of an ordinary structural grade bar would not be large enough to accommodate the full natural contraction of the concrete at such construction joint. Various factors, including the general flexibility of the framed construction used in buildings and the resistance of the reinforcing across the joint, tend to reduce such contraction. The cold-twisted twin reinforcing bars, by virtue of their greatly increased yield strength, will be more effective in resisting such contraction movement, in the same manner as they are more effective in resisting and in actually preventing the formation of concentrated large cracks at the middle of beams.

2. He suggests that hooks on twisted bars may be a potential cause of failure. In the great number of beam tests made with twisted bars, there has never been a failure in the vicinity of a hook, even in thin-stemmed T-beams. Moreover, building authorities in other countries have ruled that hooks are not required when the twisted bars are used.

3. He suggests that, at column heads, twisted bars in the lower face of thin beams may cause a bursting of the concrete. This danger does not exist; it is prevented by the restraining effect of supporting girders or columns at points of negative moment.

4. He suggests that the two individual bars in a twisted twin bar may be of different quality or grade and one bar may be on the point of fracture without detection. This is not possible, since in the twisting process any local difference or variation in the grade of the bars is either revealed or automatically corrected.

5. He argues that the ultimate strength of the cold-twisted twin bar is not increased, and the factor of safety against collapse of a structure is reduced. This is not so, since

the yield strength of the twisted bar is 64 per cent greater than that of the equivalent structural grade bar. The ultimate strength is 23 per cent greater, but it is the yield strength that is important and critical in view of the fact that a reinforced concrete beam fails when the yield strength of the reinforcement is reached. Innumerable tests have demonstrated that beams designed with cold-twisted twin bars at 50 per cent higher unit stress are stronger than beams designed with structural grade bars at ordinary unit stress. Cold-twisted twin bars, moreover, permit only a distributed series of small cracks in a beam whereas ordinary bars permit concentrated wide cracks at points of yield with resultant complete failure of the concrete.

D. B. STEINMAN
Consulting Engineer
New York, N. Y., January 28, 1938

Truthful Accounting

Sir: "Truthful Accounting" in *Engineering News-Record* of Feb. 17, 1938, p. 256, has facts submerged in it which might well be brought out.

It is stated that "Taxes of half a dozen different kinds, falling on the contractor but not on the public agency that uses the day-labor method, are likewise not charged." If the public agency does not pay compensation and liability insurance, obviously the public agency has the edge on the contractor to that amount. Any other tax burdens which the contractor has to carry must be reflected in his bids. The public agency pays no taxes and so gets another break.

Strikes are good form on contract work. As yet they are considered bad form on public work—and this is another base hit for the public agency.

Everything being stacked against the contractor, if things go on as they are now he is on his way out. If he goes out we can't tax him any more. That certainly will be bad. Reduction in taxes would help him a lot, a lot more than a correction in accounting by public agencies doing force account work.

The contractor has always had the tax handicap and in the past met it successfully. The proof of this is he is with us yet. He cannot continue to compete with agencies which pay no taxes and have no strikes when he pays taxes high as power poles and faces labor conditions such as he faces now.

A reduction in taxes and a stabilization in labor are essential if the construction industry is to survive. They would help the rest of the country some too.

C. H. HOWELL
Chief Engineer,
Los Angeles County Flood Control District,
Feb. 23, 1938

Behind Prison Bars

Sir: In the February 24 issue of the *Engineering News-Record* there is an advertisement offering a book for one dollar on "Mosquito Control Engineering."

In am serving a long sentence in the ———— prison; I have been locked up for seventeen years, and for a crime that I did not commit . . . But that has nothing to do with the request that I am making to you for one of those books.

I am paid $1.50 each month for my work in the office of the ———— ————, so I do not have very much to spend, after buying soap, tooth paste and other little things that a fellow needs and I have no other income. I have never let my folks know of my trouble, so they cannot help me.

Will you kindly let me have a copy of the book free? It will be very much approciated. I will find a lot of interesting and instructive material, and on a subject that I am interested in. I put several years in the tropics and I know about the wily mosquito . . .

No. 1234567

[To No. 1234567, a copy of *Mosquito Control Engineering* with our compliments.—EDITOR.]

Overlooked Dust Hazard

Sir: In recent articles appearing in *Engineering News-Record* relative to control of dust created by rock drilling, one particular hazard, important from the silicosis angle, seems to have escaped attention. This overlooked feature is the use of sand for stemming or tamping the drill holes in preparation for blasting. As a dust control measure I believe that sand should be abandoned as a stemming material in favor of a more efficient, safer and more economical sealing device, such as the Heitzman plug, invented by a Pennsylvania coal miner.

Let's consider what happens in normal tunneling procedure. The contractor, no doubt, is controlling the dust from the rock drilling by the use of wet drills and ventilation or other methods. After the round is drilled out he loads the numerous holes in the heading with powder and then usually tamps them with sand—pure silica. During the subsequent blast most of this sand is pulverized and blown out into the tunnel, where it remains suspended in the atmosphere as exceedingly fine dust. This dusty air is breathed by the mucking crew and other workmen coming into the tunnel following a blast. Unthinkingly, the contractor has put into the working area many times as much silica dust as was suppressed during drilling operations. His efforts at dust control have been futile, for by using silica as tamping he has increased the danger of silicosis to a greater extent than has been minimized by the drill dust control.

The procedure is about the same in dry drilling operations, even where vacuum drill dust control devices are used. The use of sand for stemming is an accepted practice largely through custom that has prevailed for years.

The safety plug, as a substitute for sand stemming, greatly reduces the silicosis danger from blasting. It increases blasting efficiency, is cheaper than sand in the long run and eliminates a serious source of silica dust.

CHARLES CAULFIELD
Eastern District Agent,
Heitzman Safety Blasting Plug Co.,
New York, N. Y.

Book Review Correction

Sir: I note on page 307 of the Feb. 24 issue of Engineering News-Record announcement of the publication of the book on "The Making and Testing of Plain Concrete", by Prof. G. E. Troxell and Harmer E. Davis, together with the statement that copies are obtainable from the authors. Copies are not obtainable from the authors but from the publisher, the Stanford University Press, Palo Alto, California.

HARMER E. DAVIS
Asst. Prof. of Civil Engineering
Berkeley, Calif., March 9, 1938

ENGINEERING NEWS-RECORD

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Volume 120, Number 11

Editor, F. E. SCHMITT · *Editorial Staff*, V. T. BOUGHTON
N. A. BOWERS, W. G. BOWMAN, W. W. DEBERARD
C. S. HILL, H. W. RICHARDSON, E. J. CLEARY

Editorial Offices at 330 West 42nd Street, New York

MARCH 17, 1938

STANDARD EQUIPMENT for bridges a few decades back comprised plank flooring, a wooden "wheel-guard" or curb, a "hub-guard" timber to keep buggy-wheel hubs from tearing out light web members, and a sidewalk. Expansion joints were unnecessary luxuries. Since those days evolution has made the deck a major problem in bridge design; its width, structure, weight, depth, surface, curbs, expansion joints, and connections with the approach roadway are matters of first importance. One important phase of the development of decks is reviewed by E. W. Bowden in this issue. The results obtained with the floors which he describes approach close to perfection. Most modern floors are so heavy, however, that the effort to save excess weight is certain to continue. The problem of a safe curb and adequate drainage provision also continues to be troublesome. Further evolution in these matters as well as in the somewhat different problem of decks for small bridges may be expected. On the principle that a bridge must present no greater obstacles or hazards to traffic than does the open road, continued study of deck construction is well justified.

Toward a Water Policy

AN IMPORTANT CONTRIBUTION to our knowledge of water-resource potentialities is made by the National Resources Committee's second report on water projects, supplementing its 1936 report. Based on far more detailed study of streams and regions than was then possible, it sets forth in its tabulated project programs a valuable list of major improvement projects considered in the light of engineering judgment and public need. At the same time questions of public policy receive careful thought. The principal doctrines set forth invite whole-hearted approval: that drainage areas be treated as units, that maximum integrated control and use of water so far as feasible and justifiable be sought for, that the rights of states in all streams be respected, and that costs be distributed according to benefits. More specific recommendations are unfortunately not brought together, but are scattered through the voluminous text of the report, where only the chance eye will discover them; many of these conclusions are of great public importance and deserve general public attention. It should be noted that the working committee was made up predominantly of federal department officials, and the report therefore tends to be a pooling of departmental projects and opinions rather than the expression of independent authorities. For this reason the project list may be subject to some discount. Notwithstanding any minor defects of this kind, however, the report is a remarkably important study bearing on necessary future development of the country.

Costly Experience

CONFIRMATION OF EARLY REPORTS that foundation failure caused the slumping of the Wyandotte County Dam in Kansas last September is given by the report of the investigating board, just made public. As the second major accident of the kind, following the sensational failure of the Lafayette Dam in California, the Kansas case lays strong emphasis on the risks inherent in soft foundation strata at the site of an earth dam. The size of the financial risk is reflected in the fact that the Wyandotte County structure must be rebuilt from the bottom up; thus, roughly a million dollars has been wasted by lack of adequate attention to the foundation problem at the start. As the number of earth dams is rapidly growing, the possibilities of foundation trouble are becoming greater. Fortunately the advance in knowledge of soil behavior and examination during recent years makes it possible to predetermine foundation strength and forestall failure by proper design and construction expedients. The Wyandotte County accident should therefore be the last of its kind. Henceforth there can be no excuse for omitting to investigate foundation conditions thoroughly before design and construction begin. Under the best of conditions the failure of a dam foundation is exceedingly costly, and under the worst conditions—in case failure is delayed until after the reservoir has filled—it means disaster.

Road Salvage Operations

OHIO IS DOING A JOB that most states must face, namely to supply reasonably good highway service at a faster rate than first-class trunkline construction can progress. Within the limits of available money it has not been possible to build modern roads of highest classification fast enough to keep up with the growing demand. But thousands of miles of roads now inadequate and becoming obsolete, though still with many years of excellent service left in them, can be modernized without complete rebuilding. This salvage work has been taken up by Ohio on a large scale. Within the past two years more than 900 miles of old road have

been widened to full two-lane width, resurfaced with a heavy bituminous mat, and freed of minor kinks and danger spots, at barely one-quarter the cost of new trunk-route construction. The result is an excellent highway for all but the densest and heaviest traffic at cost that is easy on the taxpayer, and great reduction in maintenance cost from the excessive figures to which the deteriorating roads gave rise. The whole process is developing a new road-improvement procedure well worthy of careful study by all in the highway field.

Design for Speed

MOTOR-VEHICLE SPEEDS entered the discussions of the Highway Research Board at its recent meeting as a factor in road design. The discussions were made particularly constructive by almost complete absence of the conventional tendency to blame road troubles on speed. The meeting in effect acknowledged the significance of speed trends and forecast a beginning of research into their relation to design. This means much for the future of the road.

It might be held, with some truth, that this change gives little promise of leading to new results, since as a matter of fact road design has been influenced by speed almost from the beginning of modern road improvement. First came elimination of the New England thank-you-ma'ams and the sharp right-angle corners of the section-line road system. Later, highway engineers discarded the landscape architect's practice of laying out charming reverse curves artfully hidden from view. Steady progress in this direction has brought us many 60-mile roads and a few of 80 to 90-mile capacity. Yet in the face of this trend the place of speed in design was as often denied as conceded. It is this that makes the changed attitude of the engineering and research group real news.

Let us remember that only a few years back the man who spurted even momentarily beyond 30 miles an hour had a good chance of going to jail. Today many public officials as well as some private citizens regularly travel two or three times as fast. Even ordinary road travel, as measured by Greenshields and Swinton on a Michigan road in 1933, averaged 48 m.p.h. on pavement. The drift away from slowness continues, and the highway engineer is bound to take account of it, since the road built today must be serviceable and efficient a good many years from now.

What speed standard shall be assumed in road design? The question of course does not hinge on individual views of safe speed; until we know more than now of the mechanical, the physiological and the psychological factors involved in road safety such views are little more than temperamental opinion. As a practical matter it is known that many persons today cannot drive much faster than 40 to 50 m.p.h. without excessive strain, and it follows that speed is in part self-regulating, regardless of the ultimate possibilities of vehicle and road. But average speeds, or for that matter the maximum speeds of the majority, can hardly be taken to control even design for today's requirements—still less so design for the future.

Undoubtedly future changes in travel conditions will shift customary speeds upward. But considering only present conditions, the need for a factor of safety in road design ought to be borne in mind. A substantial margin is necessary to cover momentary variations of speed for passing or other emergency use, just as reserve power is wanted for the same purpose. A further margin is desirable to reduce driver strain, now often unreasonably high because of erratic variations in road condition and the hidden surprises that spring out of side roads and farm driveways. Darkness, glare and weather conditions call for additional protective allowances, all of them expressible in terms of speed. The 90-mile design may in practice never be required to serve for more than 60-mile speed, yet its full resources may be called into action every day.

Road design should provide not a bare minimum of safety but as much safety as possible. Curves, obstacles, warning and guide signs, should be considered in the light of much higher speeds than those usually or regularly maintained. For, obviously, if alignment and visibility are planned to fit high speeds they will make driving easier and safer at lower speeds; signs so placed as to give safe information at high speed will help the moderate-speed driver also. Safety is not a matter of precise calculation but rather a matter of eliminating wherever possible the many difficulties, opportunities for misjudgment or wrong action, and unforeseen hazards, that favor accident.

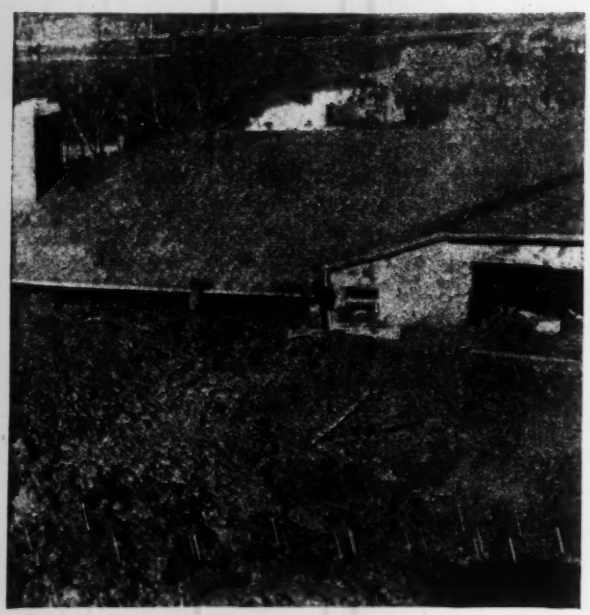
The utility as well as the safety of the road is involved in design for speed. Just how their interrelation is affected by variations in road, vehicle and driver remains a subject for future research, but we know even now that the safe road is the efficient road—it will carry more traffic for more miles and through longer hours than the unsafe road.

In the absence of standards based on research facts, it is a good working rule that momentary maximum speeds 50 per cent above travel speeds should be provided for, with regard to both safety and facilitation of traffic. This of course means high-speed design. Such design is certain to prove a paying investment, one that will usually not require much additional expenditure of money but will always require the expenditure of special care and forethought in planning.

PICTURES IN THE NEWS

W. C. Seeger

AFTER THE FLOOD ON THE LOS ANGELES RIVER. Failure and success of flood preparations are shown above. In the foreground, 2-in. shotcrete bank paving reinforced with wire mesh lies in broken slabs, while on the opposite bank in the distance is an uncompleted section of placed rock embankment which was undamaged. To the left is the detour trestle around last fall's Elysian Park slide. Part of the broken viaduct also is visible.



Acme

MUD—A FREAK OF THE FLOOD. On the bank of Silver Lake in Los Angeles, this house was invaded by a mudslide caused by the rain saturation of a hillside.

Acme

BRIDGE ABUTMENT FILL WASHED OUT leaving bare concrete piles. This bridge crossed the Los Angeles river between North Hollywood and Burbank.

Roadways on Bridges

by E. WARREN BOWDEN
Assistant to Chief Engineer, The Port of New York Authority, New York

Large bridges built by two authorities at New York City during past decade furnish an outstanding example of design trends in bridge floors

THE ROADWAYS of the bridges built at New York City by the Port of New York Authority and the Triborough Bridge Authority offer interesting examples of design developed during recent years to meet the traffic requirements of important structures of this kind. The rapid growth of vehicular traffic during the last two decades has had a marked effect on all engineering structures designed for the accommodation of vehicles. In the Metropolitan New York area, vehicular traffic movement has increased an average of sevenfold since 1915, Hudson River traffic having grown from less than 5,000,000 in that year to about 31,500,000 at the present time, and East River traffic from 11,500,000 to over 83,000,000 vehicles.

This changing traffic demand has brought about a fundamental change in the very conception of the river crossing and, as exemplified by the George Washington Bridge and the Triborough Bridge, the structures themselves have become parts of a broadly planned and executed improvement in the arterial highway system between important centers of traffic movement. Moreover, the bridge designer's problem has been affected not only by the mere increase in numbers of vehicles to be accommodated but also by the changes in the vehicles themselves, especially with regard to the recent material increases in speed of operation, in load capacity and dimensions.

The bridge roadway designs of The Port of New York Authority have all been made during the last decade. The first two of its bridge structures, the Outerbridge Crossing and the Goethals Bridge, connecting Staten Island with points opposite in New Jersey, were built in the years 1926 to 1928. They are cantilever structures. The George Washington Bridge (suspension) and the Bayonne Bridge (steel arch) were undertaken in 1927 and 1928, respectively, and both were opened for traffic in 1931.

The Triborough Bridge Authority opened its bridge (involving suspension bridge, viaduct and a lift span) in July, 1936, and has recently started the construction of the Bronx-Whitestone Bridge, a 2300-ft. span suspension bridge which will cross the East River between Old Ferry Point in the Bronx and the Whitestone section of Queens; it is scheduled to be completed in 1939.

In preparing the designs for these bridges a great deal of study was given to roadway problems, and advantage has been taken of the opportunities available for making critical observations of the roadways under actual operating conditions. Benefiting by experience on these and other bridges, designs have incorporated such modifications as have seemed desirable.

General criteria

Certain general criteria have been used in designing the bridge and approach roadways as follows:

1. Roadways should be built for at least two traffic lanes in the same direction, with a minimum width between curbs of 22 ft. Additional lanes should be at least 10 ft. wide.

2. Roadways should be widened and banked on curves to allow for reasonable traffic speed consistent with the location, transition to be provided with respect to curvature and width.

3. Grades should be kept as flat as possible consistent with drainage and, wherever possible, limited to 4 per cent on main ramps carrying truck traffic, and to 6 per cent on connections carrying passenger automobiles only.

4. Roadways should serve one-way traffic only, so that opposing traffic lanes may be separated by a safety barrier. This arrangement is not always feasible but was adopted on the George Washington and Triborough Bridge decks and is to be used on the Bronx-Whitestone Bridge.

Traffic lanes

The earliest specifications of the Port Authority required a lane width of 10 ft. with a minimum clear width of roadway between curbs of 20 ft. However, recent investigations of vehicular width and safe operation have led to the conclusion that while the 10-ft. lane is ample for the accommodation of automobiles, it is desirable to increase the width of the outside or trucking lane to 11 ft. 6 in. and to provide not less than 22 ft. between curbs in a two-lane roadway. At present a few trucks and buses are found with widths up to 9 ft. although vehicular widths are now limited to 8 ft. by law in 43 states, and in at least 3 other states may be greater only under certain extenuating circumstances.

Experience on parkways in the New York metropolitan area has been that more vehicles per lane per hour can be accommodated when ample widths are allowed, and the trend on such parkways is toward 12-ft. lanes whenever these can be provided. On a bridge, however, where closer traffic supervision is given and where the speed of driving is naturally reduced, it is believed that ample accommodation is secured with somewhat lesser widths.

On the Outerbridge Crossing and the Goethals Bridge four traffic lanes are provided in a width of 42 ft. between curbs. On the Bayonne Bridge the width is 40 ft. between curbs with an arrangement such that the roadway can be widened to a

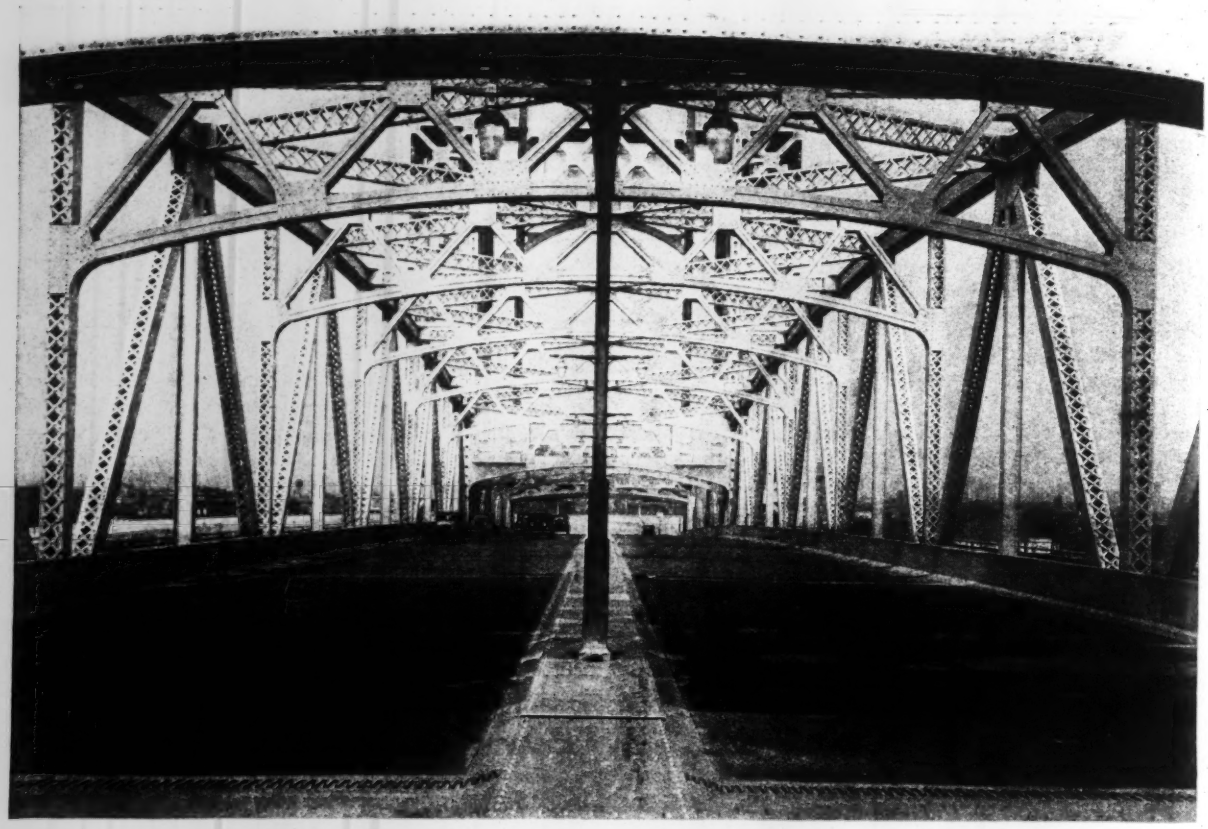


Fig. 1. Asphalt plank on welded steel plates give the Triborough lift span a lightweight deck

seven-lane capacity or may be supplemented by two rapid transit tracks. The George Washington Bridge has a roadway width of 90 ft. between outside curbs. Initially, however, the central portion of this area has been left unpaved and traffic operates on two roadways adjacent to the outside curbs. Since there were no structural limitations requiring economy in lane width, the intermediate curbs were located to make each roadway 28 ft. 9 in. wide, a space which is ample for the movement of two trucks abreast. When, in the future, it is desired to increase the roadway to its full capacity, either the center area may be paved without changing the present intermediate curb location or the intermediate curbs can be moved from their present position to the center of the roadway where connections to the secondary floor-beams have been provided. With the latter arrangement the bridge would have two 43 ft. 9 in. roadways separated by a center curb 2 ft. 6 in. wide.

The Triborough Bridge has two 4-lane roadways each 43 ft. 6 in. wide between barricades on the Bronx to Queens section of the bridge, and two 3-lane roadways each 33 ft. 6 in. wide between barricades on the Manhattan branch of the bridge. In each case the width includes a new type of sloping concrete curb 5 in. high, which occupies 1 ft. 6 in. of each side of the roadways.

The Bronx-Whitestone Bridge will have two roadways, each 27 ft. 6 in. wide between inclined steel curbs. This width is intended to accommodate two lanes of one-way traffic under normal operating conditions and, although not of the full width recommended for the ordinary use of three lanes of mixed traffic, will be ample for the movement of three lanes of pleasure cars at peak hours.

Varying amounts of lane widening and superelevation on curves have been used on the bridge and approach roadways as dictated by the conditions peculiar to each problem. For example, on the Triborough Bridge at the location where the Manhattan approach ramp curves to join the East River Drive, and where the radius at the center barricade between roadways is 187½ ft., the 3-lane outside roadway is widened from the normal 33 ft. 6 in. to 38 ft. 4 in. and the inside roadway to 39 ft. 10 in. The superelevation in this section is ½ in. per foot of width, and transition is used at both ends of the curve. On another section of the Triborough Bridge, namely on the viaduct north of the anchorage on Ward's Island, where the minimum radius is 1200 ft., no lane widening is provided but a superelevation of ¾ in. per ft. is used.

At the Triborough Bridge junction structure on Randall's Island the restrictions in areas available were such that it was not deemed advisable to widen the 3-lane curved connecting roadways, although radii are as small as 240 ft. at certain points. On the sharper curves, roadway banking is 15 in. in the 33 ft. 6 in. width, and on the easier curves is 7½ in. It is necessary for vehicles to operate on the sharper curves at greatly reduced speeds. However, the only vehicles so affected are those passing from Queens to Manhattan or from Manhattan to the Bronx, all told not over 20 per cent of the total bridge traffic, so that neither the general bridge operation nor its

capacity is limited by this condition.

For each of the bridges under discussion, the choice of floor type was made and the design prepared on the basis of careful study of the particular conditions involved. However, it is not the intention of the writer to attempt to argue in favor of these types as against different roadways used elsewhere since no particular type is suitable for all conditions, nor is any given design the only satisfactory solution for the problem in hand. Moreover, our knowledge of the subject of light-weight floors is being advanced so rapidly at the present time that it would be extremely unscientific to claim the ultimate of perfection for any one type.

Roadway structural design

The Outerbridge Crossing and the Goethals Bridge, which are cantilever structures, have 9½-in. concrete slabs with finished concrete wearing surfaces and provision for the possible addition of a 1½-in. future pavement. Transverse reinforcement consists of ½-in. square bars, 4½ in. on centers, in the top and bottom of the slab. Every third bar of the bottom layer is trussed over the longitudinal stringers. Longitudinal rods are ½-in. in diameter and are spaced approximately 12 in. on centers in the top and bottom of the slab, the top rods being 2¼ in. from the surface of the slab and the bottom rods 1¼ in. from the underside. The slab weighs 121 lb. per sq. ft.

The Bayonne Bridge and the George Washington Bridge have identical concrete roadway slabs. Both utilize 6-in. 14-lb. bulb beams embedded in the slab as the main carrying members. These are placed longitudinally, spaced 15 in.. between centers and are riveted to the secondary floorbeams. Transverse reinforcing consists of ½-in. tie rods, 12 in. apart, located 4 in. above the bottoms of the bulb beams, and ½-in. reinforcing rods, 6 in. apart, placed on top of the beams and tied together with ½-in. longitudinal rods spaced midway between the beams. The top of the slab is 2½ in. above the top of the bulb beams, giving a thickness of 8½ in. at the beams. Between the beams the bottom of the slab is haunched 3 in., reducing the thickness to 5½ in. The slab thus has an average thickness of 7 in. It weighs 97 lb. per sq.ft. and is designed for 18,000-lb. wheel loads plus 75 per cent impact; the unit stresses are comparatively low. Provision has been made in the design for the addition of a 1½ in. surfacing at a later date.

Bulb beams for the unpaved center portion of the George Washington Bridge roadway were furnished and erected with their tie rods at the same time that the side roadways were constructed in order to take advantage of the economy of a single rolling operation in the mills and in order to provide a protective grating over the open framing.

On the approach structures of the George Washington and Bayonne Bridges, a 9-in. reinforced concrete slab is used with 6-in. reinforcing trusses located at a depth of 2 in. from the top of the slab and 1 in. from the bottom. These reinforcing trusses are placed transversely. Longitudinal reinforcement consists of rods ½ in. in diameter.

On the East River Crossing of the Triborough Bridge the concrete slab has a thickness of 7 in. and weighs 99 lb. per sq.ft. Longitudinal reinforcing trusses are spaced 6 in. on centers. They are 4½ in. deep, which allows a 1¾ in. cover over their tops and a spacing of ¾ in. between the bottom of the truss and the bottom of the slab. Round rods of ½ in. diameter passing through the trusses near the top and bottom chords provide the transverse reinforcing. The same type of slab is used on the plate girder viaduct structure of the Triborough Bridge except that the slab is 8½ in. thick and the longitudinal trusses are 6 in. deep.

This type of slab has been used on the largest bridges built during the last few years. For example, the Ambassador Bridge at Detroit uses a 6-in. slab with reinforcing trusses 4½ in. deep placed transversely and spaced 6 in. between centers and with longitudinal rods. The Golden Gate Bridge also has a 6-in. monolithic slab utilizing welded reinforcing trusses. The San Francisco-Oakland Bay Bridge on its upper deck uses a 6-in. slab with the same type of reinforcement. In this slab, however, the lower 5¾ in. is a light-weight concrete with a burned clay aggregate, while the ¼-in. wearing surface consists of sand and cement mortar. The lower deck, where heavier vehicles are carried, is 6½-in. thick and uses stone aggregate.

The floor slab of the Bronx-Whitestone Bridge is included in the contract for floor steel and cables recently awarded. It will be of the I-Beam-Lok type, proposed by the contractor in place of the design originally shown, which would have made use of special rolled rail shapes as the principal stress members in the slab. As it will be built, the slab will contain special rolled 4½-in. I-shapes, placed longitudinally, 6 in. apart and connected at the top flanges by 1 1/16 in. x 3/16 in. transverse bars spaced 6 in. apart. These bars pass through slots in the web of the I-sections and are welded to the top flanges. Near the middle of each 5-ft. panel, between cross-beam supports, four closely-spaced transverse 1¼-in. x ½-in. bars pass through slots in the sections just above the bottom flange. They are tack-welded to the web of each section and are spliced by butt-welding. The slab steel is arranged so that the lower flanges of the sections can be

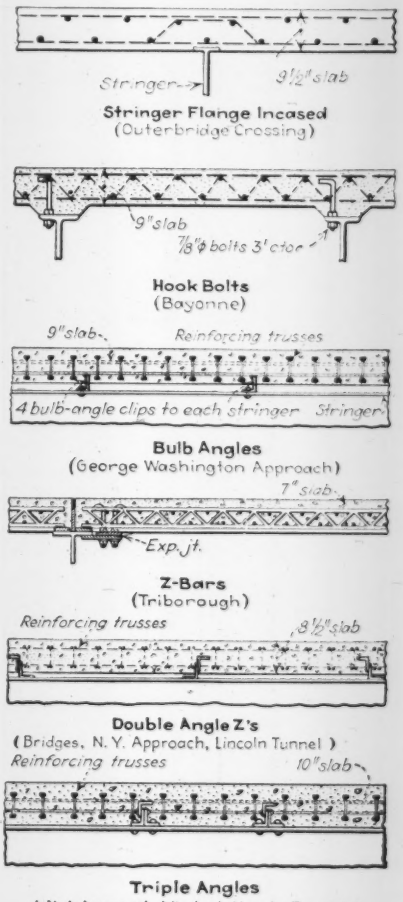


Fig. 4. Progressive development of details for anchoring slabs to steel supports.

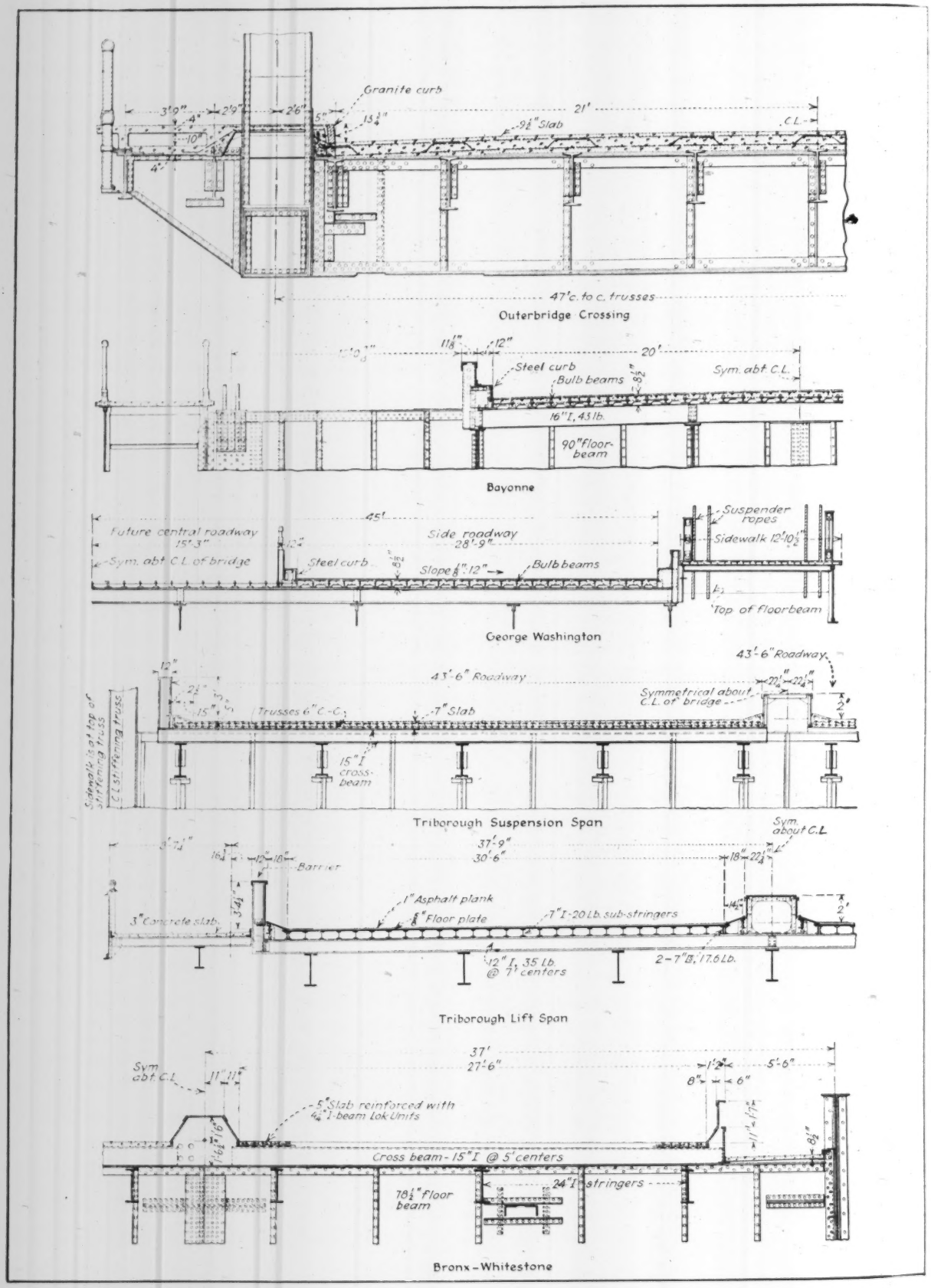


Fig. 2. A decade of bridge roadway design as reflected in well-known bridges at New York.

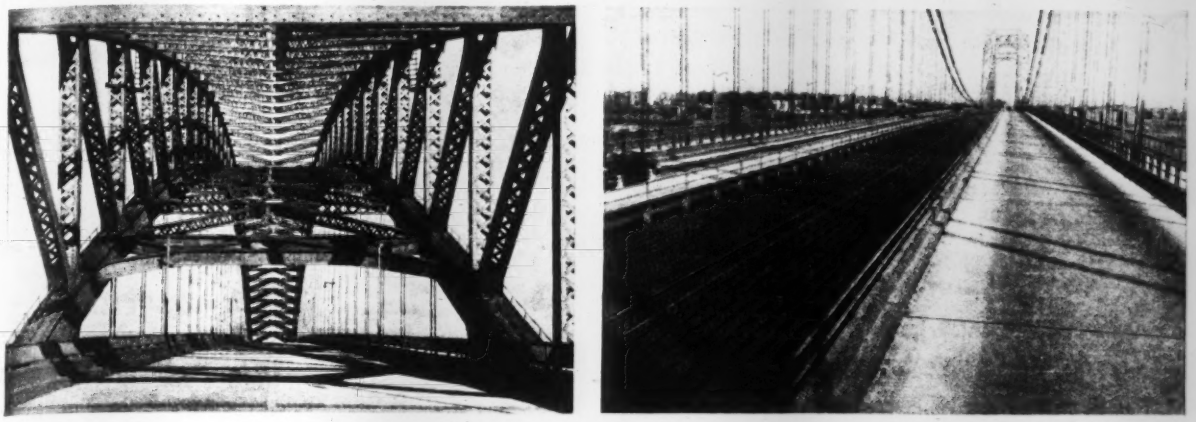


Fig. 3. Roadways on the Bayonne Bridge (left) and the George Washington Bridge (right) consist of 6-in. bulb beams embedded in concrete. The undivided deck of the Bayonne Bridge is 40 ft. wide while the paved one-way strips on the George Washington Bridge are 28½ ft. wide, the 33-ft center strip (with bulb beams in place) being reserved for future traffic.

spliced at supporting cross beams, the splicing being made by welding to these members. The top flanges of the sections are spliced by welding short bars on either side of the web.

Forms for the underside of the slab consist of No. 20 gauge sheet arched between adjacent I-sections and tack-welded to the bottom flange. The concrete will cover the steel to a depth of ¾ in. The slab is estimated to have a weight of 67 lb. per sq. ft.

No joints whatever will be provided in this pavement for the full length of each span. The flooring is made up of prefabricated units as much as 6 ft. wide and 49 ft. long. These are welded together to make a continuous mat. Omission of the pavement joints is possible because of the fact that in the cross-section of the floor system the pavement is placed at about the neutral axis of the stiffening girders which flank either side of the floor system, and will avoid participation in stress.

The concrete roadway slab of the approach viaduct of this bridge will embody no unusual features. It will be 7½-in. deep, with rod reinforcing.

The considerations which lead to the choice of roadway floor design in each case have to do not only with the weight and cost of the floor itself but with its effect on the entire structure. Under certain conditions it undoubtedly will be found cheaper to make use of lighter, although more expensive, types of floors in the interest of economy on the entire structure. For example, in the case of the Harlem River lift span of the Triborough Bridge, it was imperative to secure a light-weight floor because of the marked effect of a slight increase in the weight of the floor itself upon the entire structure, including not only the floor and trusses of the lift span but also the towers, the counterweights, the suspending ropes, the machinery, the electrical equipment and even the piers. Detailed studies were made of a large number of different types of floors and as a result a steel plate floor design was chosen. This floor consists of a ⅝-in. silicon steel plate over which is placed a 1-in. mineral-surfaced asphalt bridge plank. The plate is made continuous by full butt welds between adjacent sections and is welded to longitudinal sub-stringers which are supported on cross beams. The sub-stringers are spaced 14½ in. between centers to make proper provision for heavy wheel loads, and the cross beams are made continuous from curb to curb in order to secure maximum stiffness. Including sub-stringers, this type of floor weighs 52.5 lb. per sq. ft.

Next week the concluding part of the article will present details developed for expansion joints and for anchoring slabs to the floor.—EDITOR.

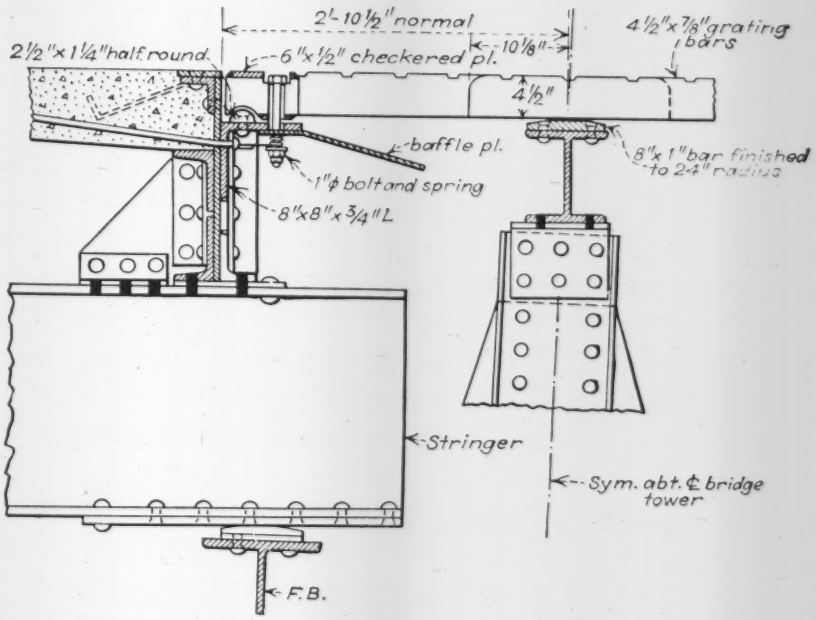


Fig. 5. Grating type expansion joint used at towers of Triborough and George Washington suspension bridges.

Testing Cement Mortars in Sea Water

by Thos. E. Stanton, Jr.
Materials and Research Engineer, California Division of Highways, Sacramento, Calif.

Four-year study shows extent to which density of mix and chemical composition of cement are factors in resisting the action of salt water when the aggregate used is unaffected by sulphates

The disintegrating effect of seawater on concrete over a long period of years varies as much with the density of the concrete as it does with the composition of the cement, according to the results of tests carried on by the writer which now have extended over a period of four years. The tests were undertaken to determine the relative resistance of California commercial cements to the attacks of sea water. Definite determinations were important because in addition to the numerous examples of marine structures that have shown distress in longer or shorter periods, there are concrete structures in San Francisco Bay which show little, if any, deterioration after 30 years or more of service even though the cement used had a high percentage of tricalcium aluminate. (This compound is referred to in the laboratory and in this article as C_3A, a short form for the bulky chemical formula.)

The series of tests and observations is still under way and in fact, only portions of the results are given in the following. However, representative examples were chosen in each case for this presentation and hence the conclusions toward which the test is trending are correctly indicated by the data presented.

Test cylinders, all of 2x4-in. size, were made with different ingredients. In order to keep the comparison of density and cement composition free of complication by any reactions having their origin in the aggregate, the aggregates were selected for their resistance to attack of either sodium- or magnesium-sulphates. Such disintegration as has occurred is therefore ascribable either to low density of the mortar, to the chemical composition of the cement, or to a combination of these two factors.

To test for the effect of density, 1:3 and 1:2 mortar specimens were made up using (1) a standard Ottawa sand and (2) a well-graded Russian River sand. The former all graded between the 20 and 30 mesh screens, whereas the latter was well graded, showing 36 per cent passing the 30 mesh, 20 per cent passing the 50 mesh, and 32 per cent retained on the 10 mesh.

To test for the effect of cement composition a variety of cements was used ranging from high to low C_3A content. Chosen for comparison in Figs. 1 and 2 are the results of two brands which have, respectively, a normally high C_3A content (17.2 per cent) and a fairly low content (7.2 per cent). Complete analyses of these two cements (*CS* and *ES*) are given in Tables II and III. The remaining specimens, in which the other brands were used, followed identically the same trend as indicated in Fig. 3. The cement *ES* is a standard commercial cement, normally low in C_3A and not a modified cement of low C_3A content such as was used on the San Francisco Bay Bridge piers. The latter (*BSW* in Fig. 3) gave even better results.

The specimens are cured in sea water which is changed monthly. All sea water used, whether for mixing or for storage, was taken from San Francisco Bay at the Municipal pier, University Ave., Berkeley. An analysis of this water (Table I) shows substantially the same chemical content as does water from the ocean opposite San Francisco.

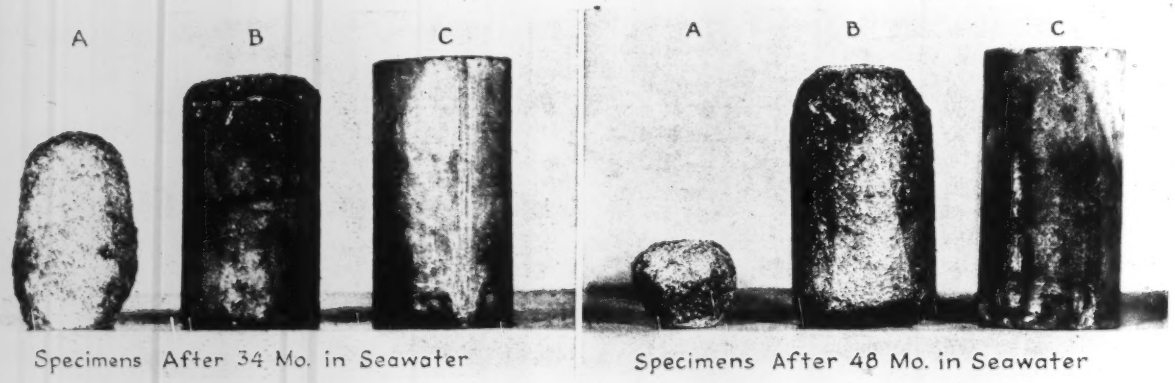


Fig. 1. Effect of density on durability of specimens cured in sea water: *A* has a 1:3 mix of standard Ottawa sand; *B* has a 1:2 mix of standard Ottawa sand; *C* has a 1:3 mix of Russian River sand. The cement used (*CS*) had a C_3A content of 17.2 per cent.

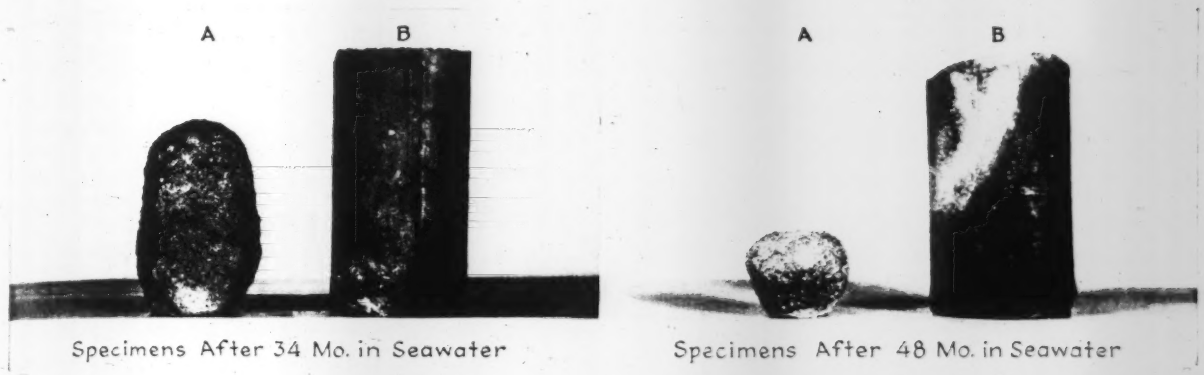


Fig. 2. Effect of cement composition on durability of specimens cured in sea water. Standard Ottawa sand, in a 1:3 mix, used in both specimens. *A* has a high (17.2 per cent) C_3A content; *B* has a low (7.2 per cent) C_3A content.

Monthly inspection of the specimens has shown that at about 15 months the upper cap (placed for compression tests which were contemplated at the time the specimens were made up) was being distorted and loosened from some of the specimens. At 17 months the first action on the specimen itself was noted, subsequent to which the deterioration of the affected specimens progressed steadily.

Fig. 1 shows the relative durability of variable-density mix using a high C_3A cement. Specimen *A*, 1:3 Ottawa sand mix, has lost 98.4 per cent of its original weight in four years, whereas specimen *C* with the same amount of high C_3A cement but with a dense mortar of well-graded sand showed no appreciable loss in the same period. Specimen *B*, in which increased density was accomplished by increasing the cement content but still using a poorly graded sand, shows results intermediate between specimens *A* and *C*.

Fig. 2 shows the effect of cement

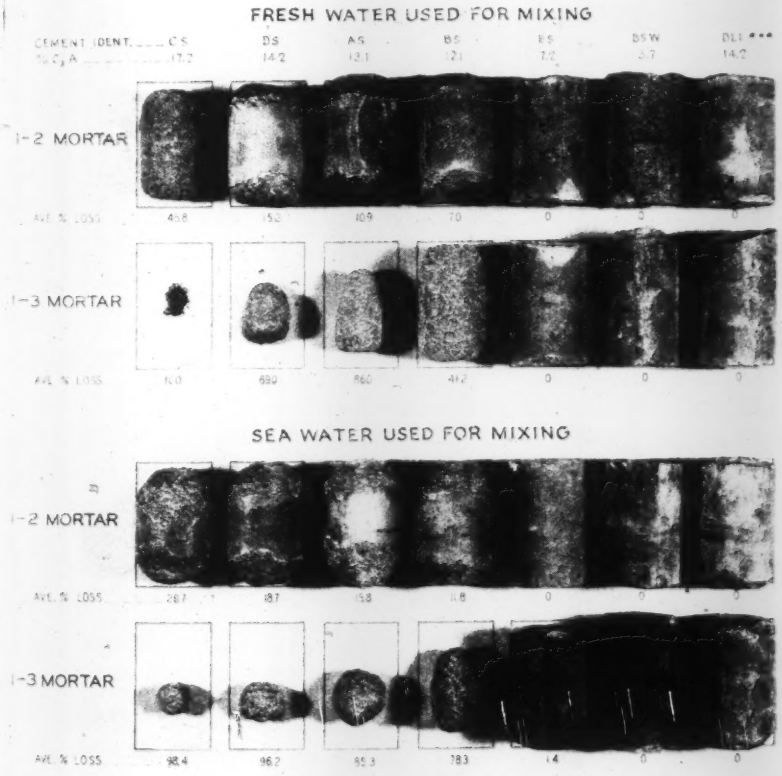


Fig. 3. Condition of test cylinders using 7 cements of different C_3A content after 48 months curing in sea water.

TABLE I — ANALYSIS OF SALT WATER FROM SAN FRANCISCO BAY

(Municipal Pier, University Ave., Berkeley,

		Parts per million	
		Low tide	High tide
Residue at 110 deg. C.		33304	33774
Free ammonia	N	.06	.08
Albuminoid		.37	.34
Carbonates	CO_3	Nil	Nil
Bicarbonates	HCO_3	142	142
Chlorides	Cl	16300	16500
Sulphates	SO_4	2403	2477
Silica	SiO_2	14	7
Iron and alumina	oxides	8	7
Lime	Ca	474	509
Magnesia	Mg	1149	1138
Alkalies-calculated	Na	9063	9308
Total Hardness	$CaCO_3$	5896	5937

TABLE II — CHEMICAL ANALYSIS OF CEMENT

	CS	ES
SiO_2	21.40	22.94
Fe_2O_3	2.27	2.03
Al_2O_3	7.94	4.05
CaO	63.81	65.16
MgO	1.40	1.63
SO_3	1.67	1.55
Loss	1.62	2.76
Ins	.18	.42
Free lime	.94	.50
C_4AF	6.9	5.8
C_3A	17.2	7.2
C_3S	32.4	59.2
C_2S	36.7	20.0
Iron modulus	3.50	1.99

TABLE III — PHYSICAL ANALYSIS OF CEMENT

	CS	ES
Specific gravity	3.13	3.10
Fineness		
—100	99.2	99.3
—200	84.9	94.6
Surface area	1200	1570
Normal consistency	22.8	23.2
Soundness	O. K.	O. K.
Time of set		
Initial	2 hr. 30 min.	3 hr. 00 min.
Final	4 hr. 15 min.	4 hr. 15 min.
Tensile strength		
7 day	320	350
28 day	420	440

composition. Specimen *A* (the same as specimen *A* in Fig. 1) shows the low resistance of a 1:3 Ottawa sand with high C_3A cement mortar. Specimen *B* shows the greater durability of the same low density mortar when a relatively low C_3A cement was used. Specimen *B* lost only 1.4 per cent in 48 months as compared with 98.4 per cent loss in specimen *A*. Other 1:3 Ottawa sand mortar specimens in which lower C_3A Bay Bridge cements were used showed no loss at all in 48 months.

Fig. 3 is arranged to show the relative sea water durability of seven Northern California commercial cements, 6 of which range from 17.2 per cent to 3.7 per cent in C_3A content. The seventh (*DLI*) is a Portland puzzolan cement manufactured from a 14.2 per cent C_3A clinker. It will be noted that the mortar from cement manufactured by the addition of 30 per cent silica compound to a high C_3A clinker developed considerable resistance to sulphate attack. Whether this resistance arises from any puzzolanic nature of the added silica or from a denser mix is not, at present, known.

In preparing these specimens, theoretically all proportioning was done by volume; however, the amounts required for each batch were measured by weighing. Therefore, with weight proportions fixed on the assumption that all cement was of uniform specific gravity, about 25 per cent more by volume of the low-specific-gravity high-specific-surface Portland puzzolan cement was used in each specimen than of the normal specific gravity cements. This conforms with construction practice, as this special cement is sold on a weight basis and one sack of 94 lb. measures about 1.25 cu.ft.

In Figs. 1 and 2 density of specimens shown varied as follows:

1:3 Ottawa Sand	2.018
1:2 Ottawa Sand	2.18
1:3 Russian River Sand	2.328

The results illustrated in Fig. 3 indicate that durability is affected to a much greater extent by the storage water than by the mixing water when both mixing and storage waters are similar to San Francisco Bay water. The specimens shown are representative samples from several sets. In the group cured in sea water the companion specimens mixed with sea water but cured in fresh water showed no disintegration. The specimens in the extreme right hand column (*DLI*) were made with Portland puzzolan cement consisting of 70 per cent standard clinker and 30 per cent silica compound: its C_3A content was that of standard Portland cement clinker only. The irregular edges in the three right hand columns resulted from the removal of the caps originally placed with the intention of testing all specimens for compression.

Timber Storehouses Built For Mill Refuse Fuel

A frame roof of 52-ft. span is designed to resist internal impact stresses and does so without tie beams

SAWMILL REFUSE useful as fuel, chiefly in the form of chips, planing mill shavings and sawdust, is stored by the Weyerhaeuser Timber Co. at Everett, Wash., in timber structures designed to perform, at minimum cost, three necessary functions, namely: (1) to prevent the wind from blowing the refuse about, thereby creating a fire hazard; (2) to confine it within designated space limitations to and from which it can be handled conveniently and (3) to keep it in burnable condition by sheltering it from rain and snow. Two such storehouses, shown in cross-section in the accompanying drawings, illustrate designs of timber structures that adequately serve these purposes. In structures of both types the material to be stored is brought in by overhead belt-conveyors and taken out by drag conveyors under the center line of the storage pile.

The quantity of fuel stored varies constantly; the storehouses usually are completely filled and emptied each week. Hence to avoid interference with the free flow of the material into storage and out again, it is desirable not to use uprights or other roof supports within the space used for storage. This requirement is met by a structure consisting

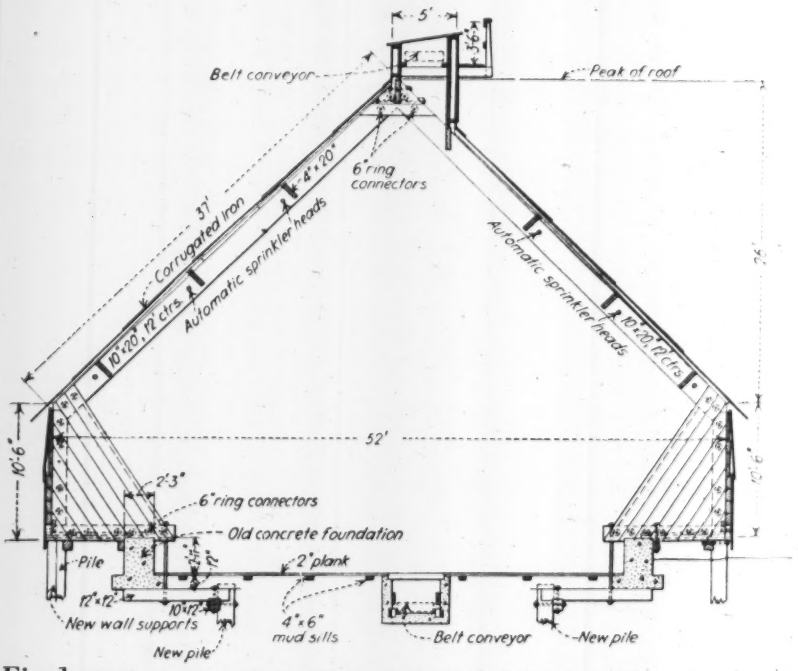


Fig. 1. Fuel storehouse designed to carry horizontal thrust in old concrete foundations built for a narrower structure.

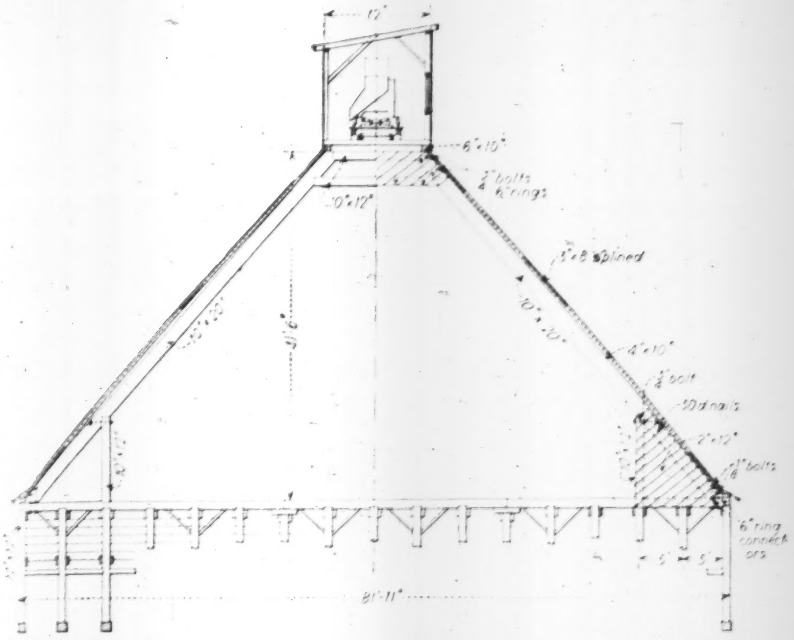


Fig. 2. Cross-section of storage bin of a type using a horizontal tie. Note detail at right corner by which tension is transferred to the tie.

primarily of a roof whose design is a row of simple A-frames, spaced 12 ft. on centers. This design provides bays for economical spacing of automatic sprinklers and the framing is made heavy enough to carry dead and live loads as well as to take up the horizontal thrust resulting from outward impact-pressure of the fuel. This latter requirement arises from the fact that as the storage space is filled the fuel has a tendency to avalanche outward from time to time, thus causing internal impact that tends to force out the side walls.

In Fig. 1 is shown a cross-section of the fuel storage house built at Everett on an old concrete foundation that served a previous structure. To make use of the existing foundation a design was developed in which the side walls of the new structure are supported on piles outside the old foundation. This gives some 12 ft. of additional width to the building and makes use of a timber frame to tie the pile supports into the concrete footings in such a way that the concrete will take the outward thrust. This design has been successful in eliminating the need for any transverse tie beams across the storage space. Obviously this would not be an economical design if an entirely new structure were to be planned.

To transmit horizontal thrust the lower ends of the rafters and the uprights against which they abut are fastened by 3x12-in. timbers to a horizontal member bolted to the concrete foundation. At the same time that the 3x12's take a tension load, the use of split ring-connectors and the placement of the 3x12's skin tight has the effect of a gusset in the frame that gives additional stiffness and stability. This building is functioning safely with a 52-ft. span and without horizontal ties to interfere with the main storage space.

The 4x20-in. purlins shown between the rafters, in addition to providing lateral bracing for the rafters, serve as baffles to prevent smothering the sprinkler heads when the fuel avalanches.

A structure of somewhat similar type, though with a fundamental difference in the provision of a horizontal tie, is shown in Fig. 2. In this case the building is 82 ft. wide and a rigid frame structure was obtained by the use of 12x12-in. tension members across the width of the building. These members are put in tension by fastening them to the rafters with ring connectors at the points of intersection, supplementing these connections at each end of the tie with 2x12's nailed to both rafter and tie. The connection thus developed functions as a sort of timber gusset plate.

The company has two storehouses of the type shown in Fig. 2 in which the drag conveyors run at right angles to the centerline. The hoppers over these conveyors are supported by the transverse tie beams on 12-ft. centers. The tie beams, in turn, are carried on post supports spaced 5 ft. apart.

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U. S. Bureau of Roads Oversees 22,000 Miles

More than 22,000 miles of highway of all classes were completed under the supervision of the Bureau of Public Roads in the fiscal year that ended June 30. Most of this work was done in cooperation with state highway departments and under detailed state supervision. In this class were 11,401 miles of road financed in large part with special emergency funds and 7,367 miles of regular federal-aid work.

Considerable progress was made in the federal program of grade crossing hazard elimination, in which 1,149 crossings were eliminated, 574 were protected with signals or other devices and 196 grade separation structures were reconstructed. Payments of federal funds to the states for the above work totaled $337,747,071.

Other work completed under bureau supervision included 139 miles of highway in national forests, 169 miles in national parks, 245 miles in public lands, and 33 miles of replacement of flood-damaged roads.

Work on the Inter-American Highway from the United States to Panama has continued at increased speed during the past year. Impassable gaps have been reduced to 560 miles and these should be closed rapidly when bridge construction now under way is completed. Under cooperative agreements with three of the Central American Republics, materials, machinery and technical direction are being supplied by the United States for the construction of nine bridges, and labor and local materials are being supplied by the countries concerned.

The total length of the highway will be 3,250 miles. At present there are 1,265 miles of all weather roads, 1,425 miles of dry season roads, and 560 miles of trails impassable to wheeled vehicles.

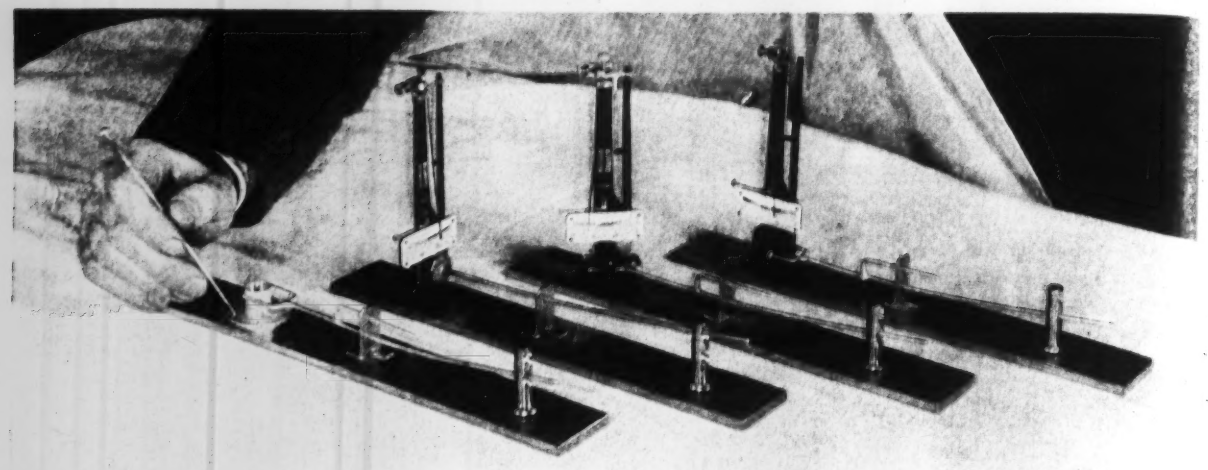

FIG. 1. TEMPLATE AND TENSOMETER MOUNTINGS USED FOR STRAIN ROSETTE WORK

Strain Rosette Technique

GEORGE E. BEGGS AND ELMER K. TIMBY
Princeton University, Princeton, N. J.

Extreme precision of measurements requires a special technique of tensometer calibration, gageline scribing and tensometer mounting

THE INTERPRETATION of data from rosette strain measurements on a plate subjected to strain in two dimensions that was discussed last week (*ENR* Mar. 10, 1938, p. 366), presupposes dependable strain readings. But in order that the readings may be sufficiently precise for practical purposes, a number of requirements must be met. In other words a proper technique must be followed, and it is to the essentials of this technique that this article is devoted.

As a beginning it is necessary that the strains be measured on short gage lines. This is particularly true where the variation of stress from point to point of the measured plate is considerable. For good results it is also important that the strain measuring instrument be oriented accurately in the direction of the measured strain line of the rosette, the error of orientation preferably not exceeding one-half degree for any one setup of the strain gage. It is further necessary that the unit strains be measured with high precision, for example accurate to 0.00001 to 0.00002 in. per in., corresponding to a unit direct stress of 300 to 600 lb. per sq.in. in a steel bar). And finally errors of orientation and measurement should be reduced by averaging a reasonable number of independent observations. These requirements of accuracy demand a suitable type of strain gage and have resulted in a special technique in its calibration and use.

Although there are several suitable strain measuring instruments commercially available the writers used 1-in. gage length Huggenberger tensometers (Fig. 1), partly because these instruments were already in the laboratory. The multiplying mechanism of this tensometer consists of two interconnected levers, the first lever multiplying the strain about 40 times and the second lever about 30 times, giving a total multiplication of about 1200. The tensometer receives the strain to be measured through a pair of sharpened steel knife edges, one fixed and one movable, pressed by spring force against the plate being measured. It is important that these knife edges be resharpened after considerable use and that the tensometer be kept clean and in perfect mechanical condition. No tensometer should be used until it has been newly calibrated on the job, and it should be recalibrated after each expert resharpening of its knife edges.

Tensometer calibration

For frequent and convenient calibration of a considerable number of instruments, the apparatus shown in Fig. 2 has proved very convenient and more precise than the instrument being calibrated. The calibrator consists of (1) a ½-in. square cold rolled steel bar securely fastened at its upper end and attached to a movable yoke at its lower end; (2) a hydraulic jack which reacts against this yoke in such a manner as to elongate the square bar; and (3) a permanently mounted strain gage with a calibrated 0.001 in. Federal dial, for indicating the total elongation of the bar in a length of 120 inches. Since the cold rolled bar has variable elastic properties

throughout its length a systematic survey of the bar, as explained below, is necessary to evaluate these variations and to provide correction for them.

The ratio of the elongation of any element of the bar, dL, to the elongation of any other element is always constant since the elastic limit of the bar is never exceeded. Therefore, it is evident that the Federal dial may be used to determine the elongation of any one element provided that the relative elongation of all elements is known. To obtain this information, the square bar was very carefully "surveyed" with several tensometers, attached with a U-shaped wire clamp at the middle of each of 19 elements, dL, which tensometer locations are defined as calibration stations. All elements were 6 in. long except at either end where 9 in. elements were used. The "calibration factor" for any station

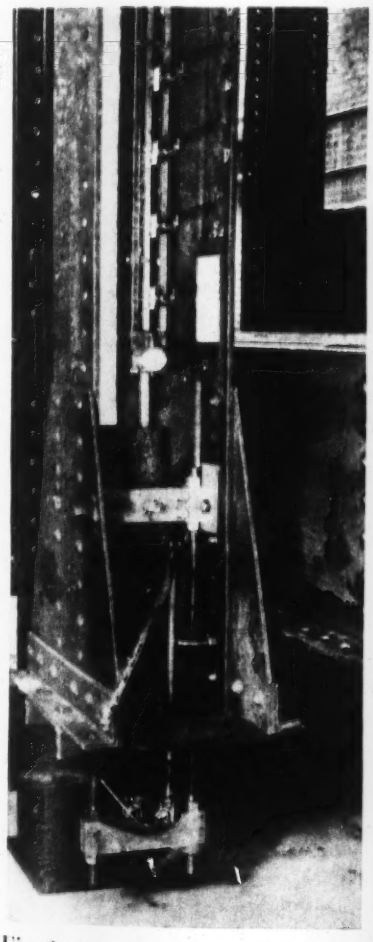

Fig. 2. **Tensometers were calibrated by checking them against a 120-in. steel bar elongated with a hydraulic jack.**

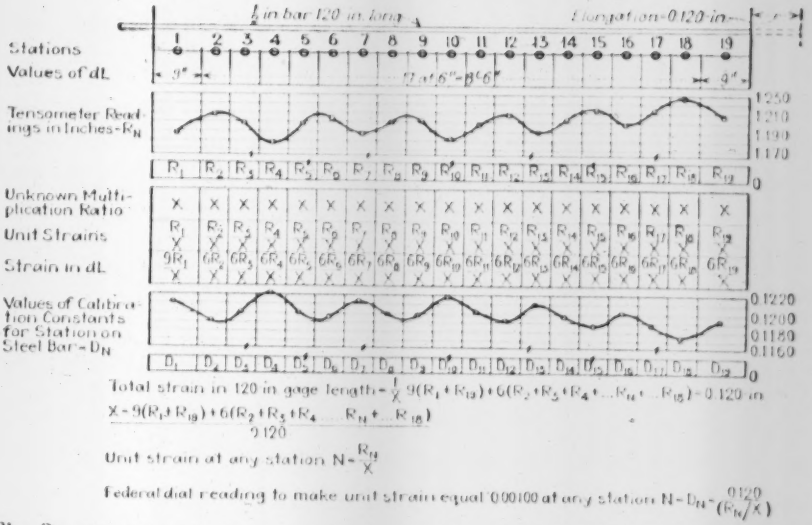
½ in bar 120 in long
Elongation=0.120 in.
Stations
Values of dL
Tensometer Readings in Inches-R_N
Unknown Multiplication Ratio
Unit Strains
Strain in dL
Values of Calibration Constants for Station on Steel Bar=D_N
Total strain in 120 in gage length=$\frac{1}{X}9(R_1+R_{19})+6(R_2+R_3+R_4+\ldots R_{18})=0.120$ in
$X=\frac{9(R_1+R_{19})+6(R_2+R_3+R_4\ldots R_{18})}{0.120}$
Unit strain at any station N=$\frac{R_N}{X}$
Federal dial reading to make unit strain equal 0.00100 at any station N=$D_N=\frac{0.120}{(R_N/X)}$

Fig. 3. Formulas governing the use of a steel bar with variable modulus of elasticity in calibrating tensometers with 1-in. gage length.

is the reading of the Federal dial which corresponds to an elongation of 0.00100 in. of the same 1-in. station. The location of the calibration stations along the calibration bar is fixed by means of a steel tape attached to one bar of the 120-in. strain gage. (See Fig. 2). Six different tensometers were used, and the results of the several surveys averaged to obtain the calibration factor for a station. The use of a single tensometer in making this survey was as follows, and is summarized in Fig. 3.

While the tensometer was mounted successively at each of the stations, the 120-in. gage length was elongated a total of 0.120 in. and the corresponding increment of the reading of the tensometer observed. Vibration was used preceding each reading to eliminate friction in the tensometer. The average of three such increments was denoted as R_N, where N was the mark of the station. The summation of the products R_N (dL) for the 19 stations was then determined, representing the total increase in length of the 120-in. gage length in the scale units of the same tensometer.

Next the reading of the Federal dial required to produce an elongation of 0.00100 in. per in. at any station N was obtained by the procedure illustrated in Fig. 3. This reading was the desired calibration factor D_N for the station. These values of D_N are proportional to the varying modulus along the cold rolled steel bar.

Since calibration factors for stations on the bar were selected to produce a strain of 0.00100 in. per in. at the station at which the tensometer was mounted; since the scale of the tensometer reads directly in inches, and since the gage length of the tensometer is 1 in., the reading of the tensometer in inches multiplied by 1000 gives the multiplication ratio of the tensometer.

Mounting the tensometers

The mounting of a tensometer on any one of the four gage lines of a rosette also requires unusual care. The attaching devices must not participate in the strain of the measured specimen in such a manner as to cause errors in the observed strains, and they must insure that the tensometer is accurately oriented on a precisely drawn rosette; the instrument must be stably mounted; and its pressure against the specimen must be reasonably constant for each remounting of the tensometer. Vibrations of high frequency and low amplitude should also be used to eliminate friction in the tensometers.

A special jig for the precise drawing of rosettes and the attachments for mounting a tensometer are shown in Figs. 1 and 4. The rosette jig consists of a circular plate with a hole at the center for accurately locating it on the specimen and with eight milled grooves equally spaced around its circumference, each groove having a width equal to the length of the tensometer knife edges.

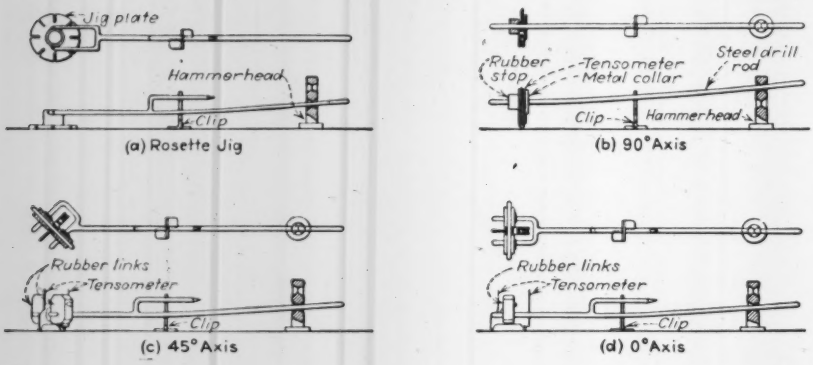

Fig. 4. Apparatus for scribing rosettes on specimens and for mounting the tensometers.

After the area of the strain rosette is lightly painted on this specimen with India ink, which is allowed to dry, the jig is mounted, using a hammer-head and a clip soldered to the specimen as shown in Fig. 4 (a), and a sharp edged tool is used to remove the ink from the areas exposed by the eight grooves in the circular jig plate. The jig is then removed and a chisel-pointed compass centered on the rosette is used to draw a circle of one 1-inch mean diameter and about $\frac{1}{16}$ in. width. Fig. 1 shows tensometers mounted on rosettes of this pattern in which the gage lines for convenience are designated by the directions 0, 45, 90 and 135 deg.

For mounting the tensometer in the position shown in Fig. 4 (b) on the 90 deg. line, a steel drill rod is used in conjunction with the clip and the hammer-head, the latter providing the mounting pressure. A fixed metal collar and a movable rubber stop, as shown, serve to orient the tensometer at right angles to the drill rod. The problem of strain participation is not present in this mounting since the tensometer is free to rock slightly on its two points whenever there is a strain between the clip and the tensometer. Also the mounting is stable when used on the top, bottom, or side of any specimen.

The tensometer mountings shown by Figs. 4 (c) and (d) are similar to each other except for the orientation of the double prong of the attachment needle. The prongs are provided with fixed collars which insure that the center of the tensometer is located on the axis of the supporting drill rod. Also the drill rod is provided with an extension which passes through the upper hole in the attachment clip, to give stability to the mounting when the tensometer is used on inclined or vertical surfaces. An important feature of these two mountings is the provision of a pair of rubber links connecting the cross pin through the tensometer to the prongs of the attachment needle. Experience demonstrates that these links eliminate strain errors.

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Soaps, Lubricants and Pitch Processed From Sewage Grease

CONVERSION of grease recovered from sewage into such products as soap and powders, metallic soap, lubricants and pitch, is one of the new developments at the Bradford, England, sewage disposal works. Patents have been secured on the scheme, which was developed on the basis of laboratory research findings subsequently tested in pilot plant operations. Results obtained with the latter led to the design for a full scale plant, now under construction, which will handle about one-third of the raw grease output.

The plant provides for the application of a series of processes, each one operating on the product of the previous one; processing can be halted at any point if it is not desired to carry the conversion beyond a certain stage. According to a recent article in *The Engineer* the first process consists of the conversion of the grease into a crude soap which may be prepared in the form of a powder. Its uses are varied, ranging from the production of cheap scouring soaps or flakes, to the separation of minerals by flotation in the production of metallic soaps. The latter, it is said, may find large outlets in the manufacture of paints, lubricating grease, and in rubber goods.

In the second process the crude soap is extracted with solvents to remove the unsaponifiable matter from the soap, the latter being thus obtained in an almost dry form. Both these products are of considerable interest to users. Among other things, the unsaponifiable portion can be used as a protective coating or as a constituent of lubricating oil, and there are even possibilities of its use in the dyestuffs and allied industries. The pure soap in powder form may be marketed as a cheap soap. It is believed that the latter may be suitable for use in the wire drawing industry where large quantities of specially prepared soaps are needed.

Decomposition of the pure soap with acid and the production of a hard saponifiable almost pure fatty acid results from the application of the third process. These fatty acids are said to be stearine-like in character. The distillation of the fatty acid is carried on in a fourth process in which a first-class fatty acid distillate and stearine may be produced. This is said to be an excellent soap making material and a particularly high-class base for the production of metal polishes, lubricating grease, dip candles, etc. Also resulting by this last process is a hard pitch by-product for which a demand exists in the English market.

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Sewer Maintenance In Cambridge, Mass.

THE TOTAL COST of maintaining the 184 miles of sewers in Cambridge, Mass., during 1936 was $34,974, of which cleaning and flushing accounted for $6,024, according to the annual report of G. Frank Hooker, temporary city engineer. The cost for cleaning 1,806 catch basins in the city system was $6,904.

FIG. 1. WELL-LANDSCAPED WATERWORKS PLANT AT MARSHALLTOWN HAS DISTINCT CIVIC VALUE

Romance of a Midwest Waterworks

Marshalltown's 60 years history leaves the water superintendent a cumulative legacy of wornout pumps, valves and hydrants

Unlike the deacon's one-hoss shay a waterworks system wears out or becomes obsolete in parts constantly and cumulatively. Pipe lines outlast valves and hydrants. Pumps wear out before the boilers do. Wells and reservoirs may be permanent but their capacity is outgrown. Emergency flood conditions break river crossings, but a town rarely goes out of water entirely for several weeks as did Marshalltown, Iowa, the city treated in the article below.

Marshalltown was chosen to illustrate these points not because its experience is any better or worse than other cities in its class but because its historical background is typical and its subsequent ascent to a high rating in the Underwriters' classification has been attained through downright hard work on the part of its technically trained caretakers. EDITOR

WHILE Philadelphia in 1876 was celebrating the one-hundredth anniversary of the Declaration of Independence, Marshalltown, Iowa, a little city of 5,000 people, was building one of the first filter plants in the Mississippi Valley. It was a 16x32-ft. slow-sand bed with 24 in. of sand, 6 in. of charcoal and 6 in. of crushed rock supported on a perforated wood bottom. A pump suction connected to a small clear water gallery under the underdrains. These filters were part of a $47,000 plant, designed by "Engineer T. N. Boutelle who came from some place in the East," and doubtless he just "stopped off between trains and persuaded the council to employ him."

Other units included a 20-in. connection to the Iowa River, two 1¼-m.g.d. steam-driven direct acting, double plunger Knowles pumps, two 48-in. boilers, a 60-ft. chimney and 4 to 5 miles of distribution system. Except for the filter the system seemed satisfactory. At 100 gal. per capita and a 3-m.g.d. rate on the filter it was only good for 350 people or only 7 gal. per day for 5,000.

Like many a later plant this little one was overloaded before it started, but limits of capacity were not so well known in engineer Boutelle's day, as the first New Orleans rapid-sand filter fiasco many years later proved. Turbidity in the river clogged the filter badly; a second unit with porous terra cotta brick as filter medium was added, but it clogged worse than the sand.

Undoubtedly much unfiltered water reached the customer. A high typhoid incidence followed, and in 1880 the filters were abandoned for wells and infiltration galleries on the opposite side of the river. A pipe under the river led to a new pumpwell built with dry stone walls. During floods surface water contaminated the well. A spring supply was then sought, and the city got by for a number of years, until another typhoid epidemic led the newly organized state health board to condemn the spring as polluted.

In 1890 John W. Hill, waterworks engineer of Cincinnati, located a well field. Having lost a son by typhoid, he had decided to devote the rest of his life to eliminating typhoid

from drinking water. He built the Philadelphia filters and developed the idea of speeding up slow-sand filters at the Spring Garden testing station—where worked Morris Knowles, P. Maignen, George Johnson, George W. Fuller, Charles Gilman Hyde, William R. Copeland, W. W. DeBerard and a number of other early waterworks enthusiasts. Mr. Hill's well field is still Marshalltown's source of supply.

The pump record is also a fascinating story. Laidlaw-Dunn-Gordon compound condensing units replaced the worn-out Knowles pumps. Allis-Chalmers cross compounds replaced the worn-out Gordons. These new pumps, of 1916 and 1922 vintage and of 4- and 6-m.g.d. capacity respectively, are the present high-pressure units. The slip of one of these units is minus, i.e., it produces more water than the calculated displacement of plungers times the revolutions, a result—believe it or not—not entirely unknown elsewhere, the superintendent says.

One of the oldest pieces of equipment still giving first class service is an old steam gage that came with the Gordon pumps. This gage and two others that were installed in the original plant 60 years ago are still in use, and the superintendent says they not only are works of art but may be superior to modern makes.

Crisis brings new era

In 1922 ice broke the 22-in. cast-iron pipe connection to the well field and the city was without water for several weeks. The next year the old commission form of city government was voted out and a mayor-and-council government returned. By Iowa law such a government requires operation of waterworks to be in the hands of an appointed board of water trustees. The council had already received plans from Alvord, Burdick & Howson to rehabilitate the run-down plant, and the new board adopted the program after hiring A. T. Luce, one of the A. B. & H. engineers, as superintendent. Thus started a new period. Since then the plant has been under skilled supervision and the later story reflects a renaissance in waterworks practice and operation typical of many another progressive Midwest municipality.

Luce increased the supply by extending the well system, changed the method of pumping, built an iron-removal plant and strengthened the distribution system. He also added another river crossing to avert a second outage. In 1926 Luce took a position elsewhere and H. V. Pedersen, then state sanitary engineer, took over the superintendency.

In every year of the latter's encumbency he has added improvements to make the system more dependable. He broke up and removed an old failed concrete mill dam to protect the water plant from a possible ice jam. He rebuilt the pumping station building that had all but collapsed. New 10-car coal bunkers into which trucks dump from the top replaced a broken-down coal elevator system. A 1½-m.g. storage reservoir was added bringing the total storage to a day's supply. A wooden roof on the old reservoir was replaced with concrete as were the walls which the roof removal disclosed as in bad shape. Lack of rainfall in 1931 made new wells imperative and a gravel-packed well was installed with a 1-m.g.d. turbine pump. The aerator which precipitates out iron and manganese was rebuilt and a back-and-forth sludge remover of home-made design was installed in the settling tank to remove settled sludge when softening chemicals were used. The mixer was too small and the manganese interfered with the reactions so that softening was never a success. A new compact softener plant of unusual design is now nearly complete.

A new well was drilled in 1932, another dry year. It is 250 ft. deep and taps a harder supply than existing wells but will eventually have to be added to the system and provision has been made for treating this water when it is necessary to use it. It is good for 1 m.g.d. and has made it possible to avert any recent shortages.

In 1933 the old original circular pump pit was cleaned out and a 2-m.g.d. centrifugal pump installed to pump filtered water into the mains thus bringing the total pumping capacity to 12 m.g.d. Now one of the two steam units can go out of service and firemen can still count on a 6 m.g.d. supply. A new river intake was constructed and a centrifugal pump also set in the old pump well to deliver an emergency river supply into the settling tank for treatment. Thus all well pumps on both river crossings can go out of commission and the city will still have water.

All this time Pedersen has been adding annually from ¼ to ½ mile of distribution mains until the system has 57 miles of mains, 400 hydrants, 650 valves and more than 5,000 metered services.

This almost romantic historical account can be duplicated in most of the 50- to 75-yr. old medium size cities of the Middle West. In some measure it indicates the multitudinous responsibilities of the water superintendent which range from being financial godfather to detecting meter thieves, from anticipating future water consumption by air conditioning equipment to replacement of wornout hydrants and valves, from

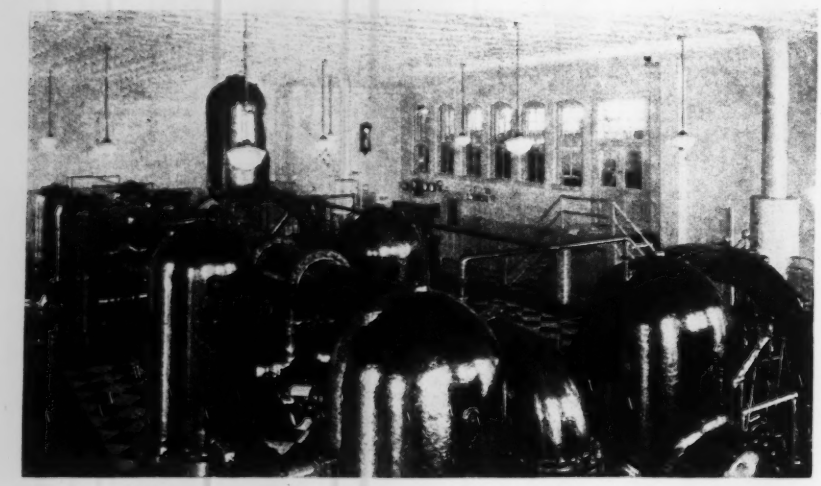

Fig. 2. Two cross-compound pumping units of 1916 and 1922 vintage still furnish high pressure to the city.

preserving the purity of the supply through taking advantage of new discoveries to modernizing pumping units and the buildings housing them.

Some further examples of how Pedersen carries on at Marshalltown in the daily routine of keeping this 60-yr. old plant in trim to meet advancing needs are given in the following paragraphs, which are the result of a long evening's visit with him. (His days are too filled with personal supervision on construction of the new softening plant piled on top of his regular routine, for daytime interviews.)

Hydrant care

Care of hydrants is handled by two inspectors who start out every year in October and go over each hydrant two or three times during the winter. Those in bad shape are spotted and pumped out frequently. These inspectors report hydrants needing repairs to the service department. The two do not go together but divide the town between them. One is employed in summer as a grounds superintendent. It is his eye for beauty that has made the Marshalltown waterworks one of the show places of the city.

Returning to hydrants, those in the congested-value areas are of first concern. More old hydrants are located here. For the last seven years ten old ones have been replaced each year as a maintenance measure. They are of the flat-head type, 50 yr. or more old, with the shutoff an ordinary gate valve on the branch. When a gate wears out no parts are available with which to repair it. It is these hydrants that leak and must be pumped out daily in winter to prevent freezing.

The valve situation

In the original distribution system the number of valves was kept to a minimum so that even now it is often necessary to deprive consumers in several blocks of water when a main breaks or must be emptied for repair. The old valves are in the same condition as the old hydrants noted above and an annual program of replacement as well as additions has long been practiced. Apparently this is not as bad a condition as it sounds since the Underwriters have not held this lack against the city in its ratings. Last year 13 new ones were cut in and 125 were repaired.

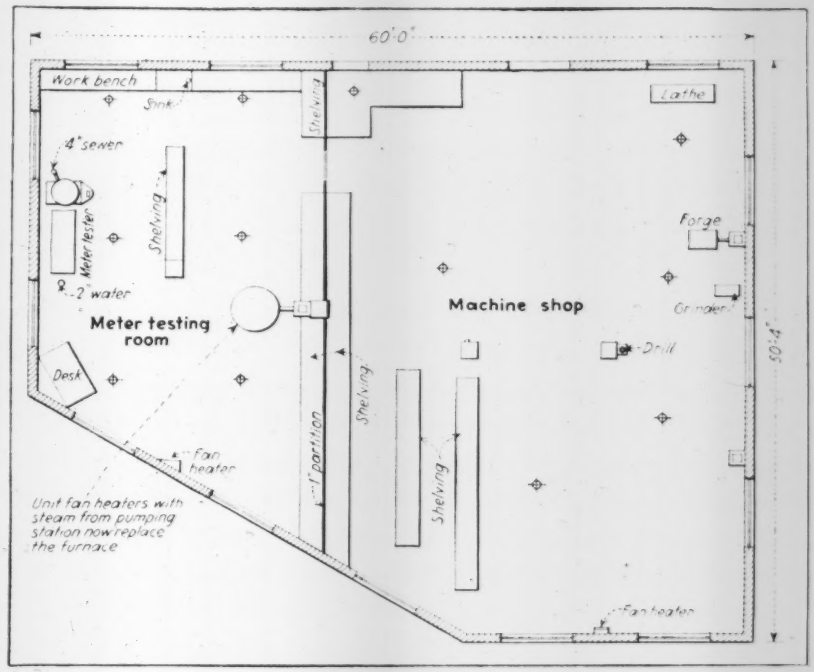

Fig. 3. Garage and storehouse are under meter testing room and machine shop shown above.

Another annual expense has been cutting the pavement and digging up the street to repack a stuffing box, replace a broken stem or make other repairs. Pedersen concluded manholes would be cheaper than digging up the street as two excavations cost about as much as a manhole. Last year 26 were built. He started out with 2 of brick then concluded to use concrete with collapsible forms as less expensive. The cost runs to $40 of which $10 is for the very heavy ring and cover which is required by the street department regulations. Covers are too heavy for removal by mischievous boys or to be carried off by thieves for junk as is done on occasion in Chicago.

New meters installed

Prior to 1932 all meters were owned by the property owner but in that year the water department replaced all old meters and installed new ones without cost to the property owner. Repairs are also borne by the department unless the damage is due to freezing or backing up of hot water.

No waterworks can long rest on its laurels, says Mr. Pedersen. It must be planned and kept ahead of the growth of the city. All waterworks equipment has a definite age limit. Centrifugal units last 15 to 20 years and heavy-duty pumps seldom over 40 years. Much equipment will not give satisfactory service beyond 5 years. Experience has taught Marshalltown that wells seldom last beyond 15 years. Knowing these end points new wells are developed from time to time. Some 50 hydrants and 200 to 300 valves are being replaced just as fast as finances will warrant this replacement.

The present bonded indebtedness, it is anticipated, will all be retired in 1944. About $100,000 per year is the income of which 30.2 per cent goes for bonds and interest, 20.5 per cent for operation, 15.1 per cent for maintenance, 10.1 per cent for administration, 7.0 per cent for the meter department and 17.1 per cent for capital improvements. Since one-third of the income goes for bond retirement it would seem logical to cut rates when the bonds are paid but Mr. Pedersen feels that the additional money should go to improvements and replacements. The new softener to reduce the 22 grains per gal. to 7 or 8 grains is thus being built on a pay-as-you-go basis without outside assistance.

Cuts and Fills

An editor's observations in the course of a trip across the continent to Denver and the Pacific Coast.

NEWS of engineering work (and perhaps society notes and the obituaries) is about the only kind of news that has retained any local characteristics. In traveling from one city to another, and reading the newspapers, one keeps track of the same murders and kidnappings, the same gossip notes from Washington, the same movies. The familiar columnists, the financial reports and the sports pages record no variation. Only in items about dams, bridges, streets, water supply, sewerage and building do we find some local color.

Leaving New York early last week, the only item of local engineering interest of the moment was the start of work on the first large-scale housing project to be privately financed under the new FHA rules set up by the recent amendments to the National Housing Act. Located in the Bowery Bay section of Queens it involved 1,250 housing units in some 400 two-story buildings covering only 30 per cent of a 110-acre site. Mortgages were taken by a life insurance company and a savings bank. It is good news and it may be significant.

Chicago had other worries. Everyone seems agreed that a much-needed express highway outlet from the Loop to the West Side should follow Congress St. However, the state highway department recommends that the north-south intersecting streets pass over a depressed Congress St. while city officials propose that the express highway be elevated at crossings. The situation presents possibilities for an interesting technical discussion.

Coming out to Denver by train averaging 65 m.p.h. for over 1,000 miles was an interesting experience. Expected sidesway and spring bumps were entirely absent, attesting to excellent track lining and spiral layouts. Apparently there is still a job to be done in damping the high-frequency vibrations of the lightweight diesel trains; normally unnoticed, these vibrations make reading difficult.

Grousing over such a minor discomfort as not being able to read recalled a previous trip to Denver made 20 years ago in a Model T. The log of that trip, still treasured, shows some days when only 10 miles were made on account of mud, records a delay of two days because of a sheared wrist pin, tells of a hail storm so severe that refuge was sought on the ground under the car. The steelbodied cars speeding along a concrete highway paralleling the railroad (and watched because one didn't want to read) were symbolic of how soft this generation has become.

We have Little Business Men, Little Steel, and other "littles." Denver is the Little Capital. No other city except Washington has as many federal offices—roads, reclamation, mines, weather, investigation, a mint, a custom house, an air corps technical school, land office, forest rangers, national parks and army posts and hospital. And of course WPA, CCC, etc.

Denver's active job of the moment is the building of a huge airfield for the Army Air Corps technical school. WPA is doing it, the government having acquired the old Agnes Phipps Memorial site, the 17 existing buildings and about 2,000 acres of land. The city of Denver as its part is acquiring an area of 100 sq. mi. of plains country which will be given to the Air Corps for a bombing range. The old buildings have been remodeled and the airport graded since work began in October, and construction of two hangars is now under way. Ten miles of 200-ft.-wide runways will be built. Nearly a million dollars is involved and some 1,500 men have been given jobs.

Fraser River water—Moffat Tunnel water, as it is called—was turned into the Denver distribution system for the first time on March 4 during a test of the new filter plant and the automatic cone valves which control flow from the new Ralston Creek Reservoir. The reservoir contains about 2,000 acre-ft. at present, about a fifth of its capacity. All of the water is supplied by melting snow on the west slope of the Continental Divide, so that the reservoir will not fill until sometime in the summer.

The other Denver water project, Williams Fork diversion to provide dilution water in the South Platte below the new sewage treatment plant, has been held up for the past six weeks as a result of a fire that destroyed the contractor's power plant. Light and ventilation were restored in the tunnel about March 1, and the compressors were to be ready to permit resumption of drilling about March 15.

Denver is justly proud of its new sewage treatment plant. None in the country approaches it in architectural appearance, and technically it is as modern as the present state of the sewage treatment art permits. From its aluminum-painted steel-conduit river crossing in two spans of 100 ft. to its batteries of circular clarifiers and sludge tanks and its skyscraper chemical house enclosed in glass block, green tile and stainless trim, it exudes modernism and cleanliness despite rather sordid surroundings. It is turning out a well-clarified effluent, using only mechanical processes. With the dilution to be accomplished by Williams Fork water there is prospect that no chemicals will be required for additional clarification.

A mild winter seems greatly to be desired but to a railroad that counts on a good deal of revenue from coal it may be a major disaster. The D. & R. G., being about 1,300 coal cars short of its usual quota, has had to cut its maintenance and improvement budget of 9 million dollars in half.

A less depressing railroad item is the news that the Denver & Salt Lake (Moffat) is going to relay its Moffat tunnel rail this summer, welding it from end to end. Heavy traffic has set up sulphuric acid fumes which have attacked the rail joints so severely that the present track, though only 10 years old, must be renewed. In the new 130-lb. rail there will be no joints, and a 20-year life at least is expected.

Denver, March 6, 1938 W. G. B.

FIG. 1. RESURFACING AN OLD OHIO ROAD WITH MACHINE-LAID ASPHALTIC CONCRETE

Ohio Starts Revamping Roads

by K. L. ROTHERMUND

Chief Engineer, Bureau of Location and Design, Ohio Department of Highways, Columbus, Ohio

Ohio roadbuilding, hampered by the diversion of road money, faces a $550,000,000 program of renovation to meet modern traffic needs

Main road improvement is fast becoming a problem of reconstruction. This is more particularly true in states that have a long roadbuilding history. In these states roads improved expensively a dozen or twenty years ago for the traffic of those times are now overrun by the doubled number of faster and larger vehicles. Ohio is one of these states. What its problems are and how they are being solved in part, are the subjects of the graphic story that follows. — EDITOR.

In 1915 there were 181,332 motor vehicles registered in Ohio; then the state had a highway system reasonably well improved for the travel that used it. Today 2,000,000 motor vehicles are using the public highways, carrying loads and traveling at speeds that were undreamed of only a few years ago. To serve this traffic Ohio has an inherited highway system which, though wisely conceived at the time it was built, is entirely inadequate for present traffic requirements.

Of the 17,000 mi. of state highways outside the limits of municipalities which are the direct responsibility of the Ohio highway department, about 13,000 mi. have a surface width of less than 20 ft. Of about 10,570 bridges on this system, more than 4,000 need rebuilding because they are either too narrow or too weak or both, for present-day traffic. Of the 2,800 railroad grade crossings on the system there should be developed a definite progressive program covering the elimination of at least 600. Practically all main highways intersect at grade, and should have their grades separated to keep abreast of the demands for safe travel. There are innumerable additional traffic hazards in sharp curves, steep grades, short sight distances, deep ditches, narrow berms, steep cut and fill slopes and pavements that are rough and high-crowned.

In considering the problem of bringing this outmoded state highway system up to a standard commensurate with present-day traffic requirements, the highway department has classified its system of highways. The main system consists principally of U.S. and state through-routes carrying the heaviest traffic and totals 3,000 mi. The intermediate system consists of state routes of less importance to through-traffic carrying a traffic load of less than 2,500 and more than 500 vehicles per day and amounts to 6,000 mi. The secondary system includes low-traffic routes which are primarily of local importance. This road system aggregates 8,000 mi.

The work of reconstructing these old roads, relocating such portions as will modernize them and make them safe for present-day traffic has been estimated to cost more than $550,000,000. To do the work the department has available a yearly construction fund derived from the

gas tax of about $7,500,000. The actual allocation of construction funds is in excess of this amount, but statutory salaries, cost of administration, preliminary surveys, rights of way and sundry claims are some of the charges which by law are paid out of this fund, leaving for actual construction purpose the amount named.

In addition to the state money available for construction and reconstruction, Ohio also has her share of federal funds. For the federal fiscal year of 1938 these additional funds amount to federal-aid funds, $5,640,344 and federal-secondary funds, $928,069, making a grand total with the state money of $15,210,117. The federal grade-crossing funds are of course used exclusively for the elimination of hazards at railroad grade crossings; the federal-aid and federal-secondary funds must be matched with state money. After matching federal-aid funds it becomes necessary to obligate additional state funds for federal projects, by reason of the financing of contingencies in which the federal government does not participate. This leaves a balance of about $1,500,000 of state money available.

A statutory provision in Ohio requiring that 45 per cent of the state highway construction fund shall be used in the several counties of the state must also be considered in formulating the highway construction program. Since the remaining 55 per cent is insufficient to match federal funds, all construction funds must be lumped and a wide-spread program of projects developed within the biennium for this requirement.

The policy in expending all funds except railroad-grade-crossing funds is to place federal-aid money primarily on the main or heavy-traffic system of highways. These projects involve design features such as adequate pavement, both as to strength and width, wide berms, shallow ditches, flat cut and fill slopes, curve reduction in alignment, adequate sight distances both vertical and horizontal which will average about $75,000 per mi. The federal secondary fund is confined to projects on the secondary system of highways and involves features of design which will bring the roads to a standard commensurate with the amount and kind of traffic involved.

This leaves the department with the problem of how to improve the mileage on the intermediate system amounting to 6,000 mi. having available about $1,500,000 with which to do the work. It is possible of course to place on this mileage improvements comparable to those being constructed on the heavy-traffic system routes; such a policy would allow the department to rebuild about

TYPES AND COSTS OF ROAD WIDENING AND RESURFACING AS OF NOVEMBER 1937 IN OHIO HIGHWAY DEPARTMENT PROGRAM FOR 1937

Description	ROAD MIX			PLANT MIX			PLANT MIX-MODIFIED			Total of all Types
	Widening Only	Resurfacing Only	Widening & Resurfacing	Widening Only	Resurfacing Only	Widening & Resurfacing	Widening Only	Resurfacing Only	Widening & Resurfacing	
Total miles	16.232	101.534	79.133	3.014	44.550	54.240	32.596	48.368	87.140	466.807
Average width of widening — feet	7.365		3.433	4.500		3.971	4.474		4.266	
Average depth of insulation course — inches			2.737			1.190	1.107		1.034	
Total cost of insulation course			34,397.10			21,211.77	10,146.58		25,163.84	90,919.29
Average depth of base course — inches	8.000		5.149	6.000		5.861	4.438		4.774	
Total cost of base course	82,280.78		190,025.79	14,060.90		241,645.42	145,685.00		359,761.48	1,033,457.37
Total cost of prime coat	3,350.89	*62.34 17,723.62	*7,078.01 5,112.94		12,773.75	19,809.49		21,139.14	*1,995.00 28,518.73	*9,135.35 108,428.76
Total cost of leveling course		104,764.25	*53,306.69 67,181.37		64,140.50	142,705.35	4,656.10	270,181.00	*27,690.00 375,898.65	*80,996.69 1,029,537.22
Average width of surface course — feet	7.365	19.553	19.713	4.500	20.793	20.000		20.283	20.189	
Average depth of surface course — inches	0.500A	1.515A	1.521A	0.500A	2.241†	2.326†	1.240A	1.261A	1.234A	
Total cost of surface course	7,640.72	*1,796.73 297,696.78	*178,644.30 125,696.64	722.62	425,766.60	466,913.61	44,136.45	279,850.74	*26,258.75 453,408.81	*206,700.78 2,089,842.97
Total cost of surface seal	2,273.13	*1,317.08 100,144.84	*76,885.22 31,668.28		4,412.60	9,697.88				*78,202.30 148,196.73
Total pavement cost	95,545.52	*3,176.15 520,329.49	*315,914.22 454,082.12	14,783.52	507,093.45	901,983.52	204,624.13	562,170.88	*56,043.75 1,239,751.51	*375,134.12 4,500,360.14
Average pavement cost per mile (see Note A)	5,886.24	5,155.96	9,730.41	4,904.95	11,382.57	16,629.49	6,277.58	11,622.79	14,870.27	10,441.96
Total cost of miscellaneous items (including earth work drains, insurance, maintaining traffic, etc.)	36,069.21	*134.72 31,820.58	*10,314.28 71,674.92	3,140.55	36,383.50	102,245.89	33,631.96	26,438.83	*3,200.00 107,185.56	*13,649.00 448,309.80
Total contract price (excluding engineering, superintendence and detours)	131,614.73	*3,310.87 552,150.07	*326,228.50 525,757.04	17,924.07	543,476.95	1,004,229.41	238,256.09	588,609.71	*59,243.75 1,346,937.07	*338,783.12 4,948,639.14
Average contract price per mile (see Note A)	8,108.35	5,470.69	10,766.50	5,946.94	12,199.26	18,514.55	7,309.37	12,169.40	16,137.03	11,114.57

*1936 Funds
†Surface and Binder
ASurface only

A — The total costs from which the average costs per mile are derived include the costs of eleven projects originally awarded in 1936 for resurfacing only, for which additional contracts were awarded for widening in 1937.

20 mi. of road per year. The department could of course compromise on standards, building new pavements of adequate width, but retaining curvature, short sight distances, narrow roadways, etc. These roads would be obsolete in design at the time they were built. There remains only one other alternative which is to salvage the old pavement as a base course, extending this base to a proper width and then resurfacing with a material which, while not excessive in cost, will assure a full return on the investment.

Program undertaken

The first resurfacing program was undertaken in 1936. Under this program the existing pavement was merely resurfaced, reducing the crown where it was excessive. The improved riding surface invited speeds which were unsafe for the width of pavement involved. In 1936 about 450 mi. of pavement was improved in this manner at an average cost of $6,500 per mi. In formulating the 1937 widening and resurfacing program a very careful study was made of all projects. Notice was taken of the past maintenance cost and those sections having a high maintenance cost per mile were given preference over others carrying a lower maintenance charge.

The 1937 widening and resurfacing program involved the expenditure of $4,948,955.14 and the improvement of 466.8 mi. of highway as shown by the accompanying table. The available construction funds were augmented by maintenance funds which made a program of this size possible. All projects whether financed with construction or maintenance funds were built under the contract system.

Types of resurfacing

Specifications have been written for various types of base widening and resurfacing to meet different conditions. To give details would extend this article beyond readable proportions but so that inquiry by any who are interested further may be definite, the general characteristics of the various types of surface courses are as follows: T-132 is a machine-laid road-mix type of medium density, using special equipment designed for power mixing with one pass of the machine and using rapid curing bituminous material. Two of the outstanding features of this type are the rapidity with which it can be laid and the ability to keep the road open to traffic at all times. T-50 hot-mixed hot-laid asphaltic concrete surface course is a dense-graded plant-mix type using 100 per cent crushed aggregate of low

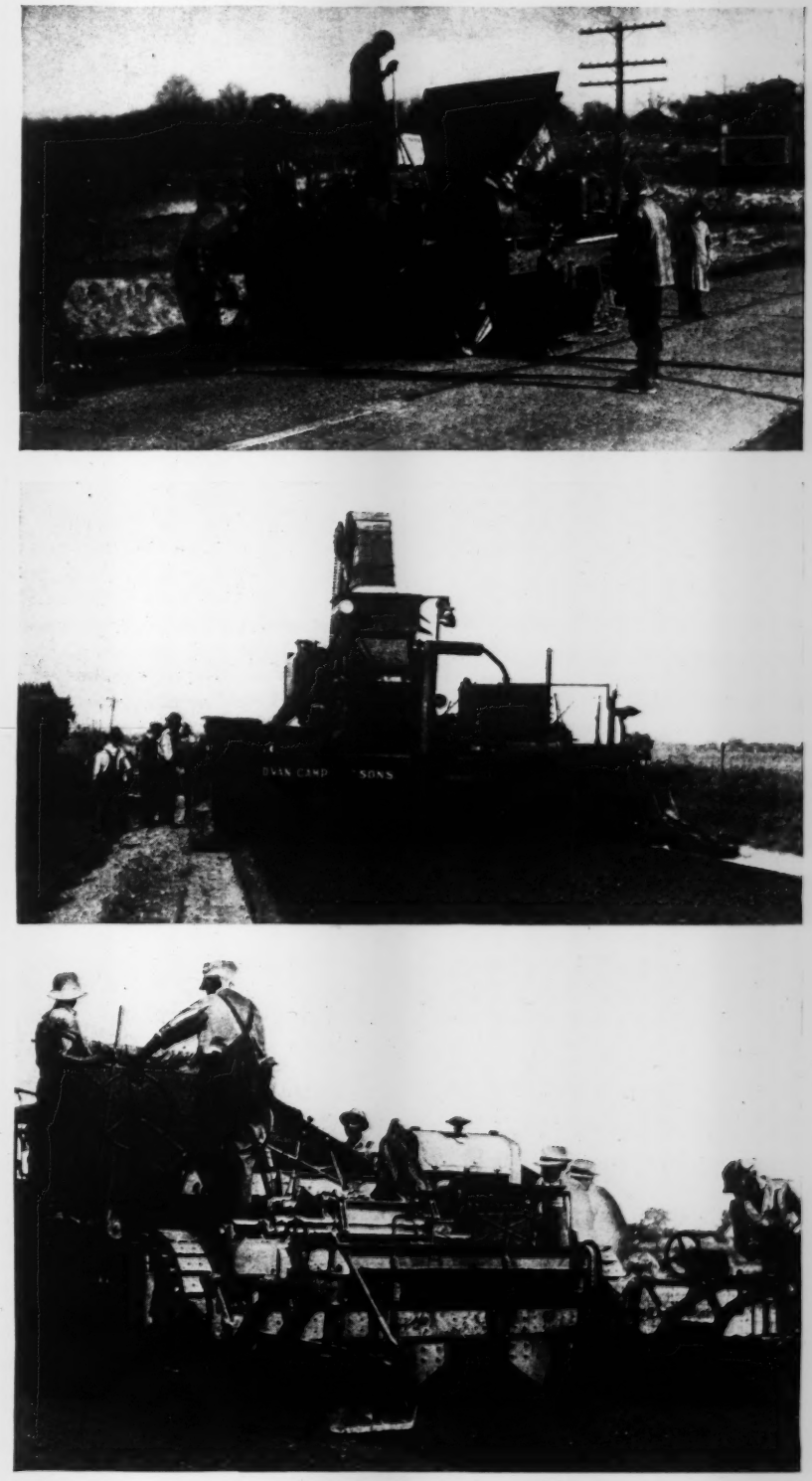

Fig. 2. Surfacing is now done with a variety of machines that accomplish every function except rolling; three types are shown here.

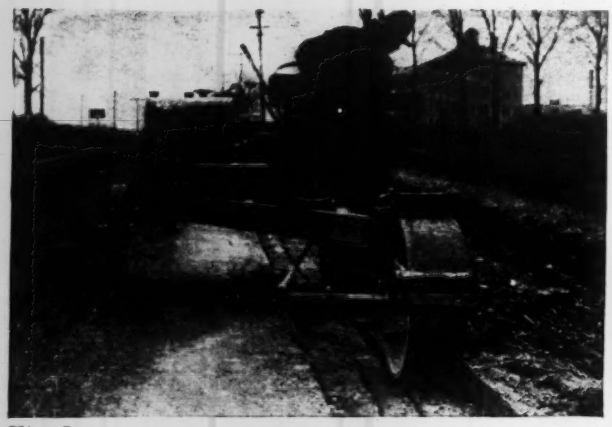

Fig. 3. In widening old pavement the shallow edge-trenches for new base are excavated by machines that cut to exact width and depth.

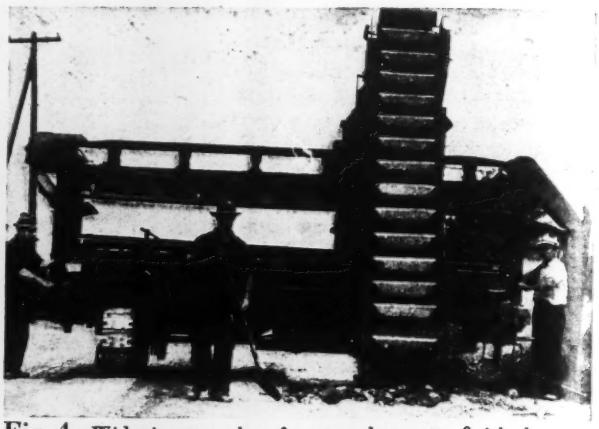

Fig. 4. Widening trenches for new base are finished by special rollers; similar traveling carriages carrying power tampers are also used.

abrasion and a large per cent of sand. Asphalt only is used in this type and no liquefier is permitted. T-135, hot-mix, hot-laid asphaltic-mat surface course is a modification of T-50 type. It provides for the use of an asphalt cement softer than that used in T-50, and requires less refinements for grading and quality of aggregates. In general the pavement is laid using special designed equipment not requiring the use of forms, and permitting the laying of the pavement in lanes thus maintaining traffic. T-60, cold-mix, cold-laid asphaltic-concrete surface course is an open-grade plant-mix material using 100 per cent crushed aggregate of low abrasion and a low per cent of sand. Liquefier is added at the plant. T-61, cold-mix, cold-laid tar-concrete surface course is an open-graded plant-mix type similar to T-60 using liquid tar as a binder.

Plan proves sound

The value of this type of work to the traveling public and to the tax payers of Ohio is beyond question. Previous investments that have been protected, and the value of the old pavements salvaged are far in excess of the actual cost of the program. The most conservative estimate which could be placed on the value of the old highway before salvaging would be its worth as a base, giving no consideration to right-of-way, structures and roadway cost. Assuming the average width of the old pavement to be 16 ft., and the cost of a new base to be $1.75 per sq. yd. these old pavements represent a value of $7,667,968.

The benefit to the traveling public in wider, more non-skid surfaces resulting in greater security in driving and in greater safety, reduced operating cost, reduced wear and tear on equipment and reduced maintenance cost to the department of highways can only be estimated. The vehicle miles traveled on the projects in the 1937 program have been computed, based on the traffic count made in 1936 by the Ohio Highway Planning Survey, and the figure is found to be 211,257,300 mi. Estimating the savings to the traveling public resulting from the improvements made at 1c per vehicle mile the 1937 program represents a total yearly savings of $2,112,257 and will pay for itself in a little over two years. Recognition by the roadbuilding equipment industry of this general type of road work is reflected in the special equipment, some of which is illustrated, developed for its construction.

Direction of program

The Ohio Highway Department in the future will give a definite place in its construction programs to this method of saving its old pavements as instituted by John Jaster, Jr., Director of Highways and G. M. Anderson, Assistant Director. The development of the actual program was under the Bureau of Location and Design, K. L. Rothermund, Chief Engineer, with B. H. Frasch, Maintenance Engineer, lending marked cooperation. Preliminary inspection of projects, planning and designing work was handled by L. R. Anspach, P. E. Masheter, C. L. Moyer and S. O. Linzell, assistant engineers.

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Electricity and Camera Aid Office Efficiency

Electricity and photography are being put to use to increase office efficiency in the two largest public personnel agencies in the country—civil service commissions of the federal government and New York City.

New York last month started using an electric scoring machine which can accurately score about 800 civil service examination papers an hour. The machine is designed to grade short-answer tests of the multiple choice or "true-false" type. (Example: the mayor of New York is (a) Valentine (b) Dewey (c) La-Guardia (d) Lehman) Candidates check their answers with a special graphite pencil which makes an electrically conductive mark that automatically registers the score when their papers are placed in the machine.

The U. S. Civil Service Commission now photographs examination papers, application blanks and other documents on small-size film for filing. A six-inch square box of film will contain 250 records. The film may be projected on a screen which magnifies them one and one-half times. The film's life: from 100 to 500 years.

THE WEEK'S EVENTS

(Continued from page 389)

Bids To Be Asked on Facing For Washington Bridge

Bids for applying a rubble masonry and cut stone facing to the anchorage of the George Washington bridge, extending the approach arch over Riverside Drive, and construction of ramps to Fort Washington Ave., will be asked shortly by the Port of New York Authority. The specifications will be ready for advertising April 1 and bids will be received about May 1. Whether the work is undertaken at this time will depend on whether the bids are within the amount of money available.

Facing of the New York anchorage of the bridge was deferred at the time of construction in order "to afford ample opportunity for unanimity of opinion on the decorative features." Bent steel rods were left projecting from the anchorage to retain the facing, and they will now be used for this purpose. The anchorage will be faced with rubble masonry and cut stone trim. It consists of a mass of concrete about 300 ft. by 200 ft. rising to a height of 85 ft. above Riverside Drive.

The extended Riverside Drive arch will be given solid spandrel walls and will also be faced with rubble masonry and cut stone trim.

In addition, two ramps, one on each side of the present center roadway, will provide easier access from the bridge to Riverside Drive. The ramps will each provide a 30-ft. roadway and a sidewalk for pedestrians.

Alternate bids will be asked either for performing all work on the anchorages and ramps or construction of the ramps only.

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Equipment and Accident Manuals Revised

The Contractors' Equipment Ownership Expense Manual, and the Manual of Accident Prevention in Construction, both compiled and published by the Associated General Contractors of America, have been revised and enlarged with the 1938 editions just off the press. The new editions mark the first revision of each manual since 1930.

Many types of construction equipment have been developed and placed on the market in the past eight years, and the new equipment expense manual includes all of them. Expense information is divided into six parts: depreciation, overhaul and major repairs, interest and taxes, ownership total expense, average use in months per year and expense per working month. The average price of each piece of equipment and the average monthly expense are also included. The manual is not to be used as a basis for rental agreements, for the expense items represent cost to the owner without allowance for profit and other considerations.

The long-popular Accident Prevention Manual has been improved and enlarged, but still retains its simple, direct appeal to those engaged in construction. It is divided into 47 sections for easy reference, each section covering a type of heavy construction work. The accident manual sells for $2; the equipment expense manual for $1. They can be obtained direct from The Associated General Contractors, Munsey Bldg., Washington, D. C.

PERSONAL

W. W. CALDWELL has resigned from the J. G. White Engineering Corp. to become vice-president and general manager of the building construction firm of Iglehart, Caldwell, & Scott of New York City. He was formerly with Voorhees, Gmelin, & Walker, New York City architects, and also with the Thompson-Starrett Co. in charge of building construction in many cities throughout the country.

THOMAS U. TAYLOR, dean emeritus of the school of engineering of the University of Texas, was honored with a memorial banquet early in January by his former students. He was presented with license No. 1 to practice the profession of engineering in Texas under the engineers license act that went into effect the first of the year.

A. R. BARTELL has been elected county engineer of Cedar county, Iowa.

A. O. BARRETTE has been made chief engineer of the Quebec department of colonization.

CHARLES H. NICHOLS has been appointed executive and technical director of the municipal housing authority of the city of Yonkers, N. Y.

RALPH H. CHAMBERS has withdrawn from The Foundation Co., of New York City, of which he has been vice-president in charge of engineering for the past ten years and will engage in consulting engineering. Before being vice-president of The Foundation Co., Mr. Chambers was for five years chief engineer of that company and was for fifteen years before that vice-president and chief engineer of Jarrett Chambers Co.

LAWRENCE M. ORTON, formerly general director and secretary of the Regional Plan Association of New York City, has been appointed a member of the newly organized New York City planning Commission.

HAROLD M. LEWIS, previously engineer and planning consultant of the Regional Plan Association, was given general direction of the association staff with the title of chief engineer and secretary. Edward McKernon, previously editor, was designated editor and assistant secretary, and C. Earl Morrow, previously principal assistant engineer, was made planning engineer.

COMMDR. F. S. BORDEN, commander of the U. S. Coast and Geodetic Survey's survey ship Hydrographer, is leaving that ship to take command of the survey ship Oceanographer.

LIEUT. COMMDR. GEORGE C. MATTISON, inspector of the New Orleans field office of the U. S. Coast and Geodetic Survey, is leaving that post to become commander of the Hydrographer, succeeding Commander Borden.

COMMDR. L. D. GRAHAM, formerly commander of the survey tender Mikawe, will take over the New Orleans office vacated by Lieut. Mattison.

FREDERICK N. CRONHOLM has announced the opening of a consulting hydraulic engineer office in Redlands, Calif.; he will give special attention to work simplification.

EUGENE O. HUMPHREY has been made engineer of maintenance of way and roadmaster for Bamberger Electric Railroad Co. He was formerly assistant engineer for the Utah State Road Commission.

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Cost Estimate Is Made On Crosstown Tunnel

The proposed tunnel under Manhattan Island in New York City connecting the Lincoln Tunnel under the Hudson River with the Queens-Midtown Tunnel under the East River, both now under construction, would cost about $35,000,000, Borough President Isaacs of Manhattan announced March 7. The estimates are based on a report by Walter D. Binger, commissioner of borough works.

OBITUARY

GEORGE P. STOWITTS, engineer of region No. 1 of the PWA, New York City, died in Montclair, N. J., on March 5 at the age of 58. Immediately after his graduation from Rensselaer Polytechnic Institute in 1900, Mr. Stowitts joined the engineering staff of the New York Central Railroad and served with that line for 20 years, rising from the position of draftsman to that of district engineer of the eastern district. He resigned from the railroad to become chief engineer of the Lord Drydock Co. and later joined the transit division of the New York City engineering department. He worked with the Foundation Co. of New York City, was engineer in charge of construction of a new line in southern Florida for the Seaboard Airline R.R., and in 1928 was engineer of design and of construction for the Union Terminal in Cincinnati. In 1934 Mr. Stowitts became state engineer-inspector for PWA in Iowa, and two years later he became chief engineer of the inspection division of PWA. He was made engineer of the New York region at the time of the reorganization last November.

WILLIAM K. RUNYON, 61, for sixteen years on the staff of the Los Angeles county surveyor, died in San Marino, Calif., Feb. 28. Mr. Runyon, a graduate of Lafayette College, spent several years after his graduation on survey work and then became resident engineer on railroad construction for the Cuba Co. After two years in China as locating engineer, he returned to Cuba and for the next thirteen years was engaged in railroad work on various lines in South America. In 1918 he became an office engineer for the U. S. War Department in Washington, two years later returned to Peru as chief of the technical department of Wessel, Duval & Co., and in 1922 entered the Los Angeles county surveyor's office.

GEORGE W. DEE, retired civil engineer formerly on the staff of the city of Los Angeles, died there Feb. 23 at the age of 43.

FRANK PAUZE, retired Montreal contractor, died there Feb. 27 at the age of 70. Mr. Pauze constructed a number of important buildings in Montreal, in partnership with his father, under the firm name of U. Pauze & Sons. After his retirement from that firm he was connected for a time with the Fuller Construction Co., New York City, but returned later to Montreal.

G. E. LUSK, 43, county engineer of Appanoose County, Iowa, died recently in Centerville, Iowa.

MAURICE A. LONG, founder and president of the M. A. Long Co., Baltimore engineering and contracting firm, died in Baltimore Feb. 27 at the age of 62. After graduation from public high school, Mr. Long educated himself through correspondence courses in architecture and civil engineering. He practiced privately for two years and joined the architectural staff of the Baltimore & Ohio Southwestern R.R. in 1899. He became architect of the Baltimore & Ohio system in 1904 and in 1913 was made assistant to the chief engineer of the entire system. He left the B&O in 1919 and organized his contracting company.

W. CLAYTON, first city engineer of Spokane, Wash., died in Los Angeles Feb. 27. He was Spokane city engineer from 1884 to 1885.

JOHN W. HOOVER, Cincinnati building contractor, died there March 2 at the age of 51.

ROBERT I. RICHARDSON, president of the Richardson Construction Co. of Cincinnati, which he founded in 1929, died there March 1.

JOSEPH W. FOOTE, 55, superintendent of the Niagara Junction Ry. at Niagara Falls, N. Y., died there Feb. 14. A graduate of St. Thomas College, Mr. Foote was for many years connected with the Erie R.R. as divisional superintendent. He served as a captain in the engineer corps during the war.

PEDER P. GJARDE, Seattle general contractor, died there Feb. 13 at the age of 63. Mr. Gjarde was engaged in the contracting business in Chicago for eight years before moving to Seattle in 1900. He established his own business in 1910 and carried it on until the time of his death. His buildings include the Volunteer Park Art Museum, an addition to the University Library, the Ranke and Volker buildings and the central Y.M.C.A.

CARL SIEBRAND, Seattle architect, died there Feb. 15. He had designed many government buildings in the state of Washington.

JAMES A. MCMURRY, engineer in charge of the income division of the Boston water department, died there Feb. 19 at the age of 61. Mr. McMurry entered the city's service in 1896 and was appointed division engineer in the year 1934.

JESSE JOHNSON, Norfolk, Va. builder and contractor, died there Feb. 23. His company, the Johnson Construction Co., erected many of the larger buildings in Norfolk.

CALENDAR OF MEETINGS

NATIONAL SOCIETIES

BUILDING OFFICIALS CONFERENCE OF AMERICA, annual meeting, Willard Hotel, Washington, March 21-25.

AMERICAN SOCIETY OF CIVIL ENGINEERS, Spring meeting, Jacksonville, Fla., April 20-23.

AMERICAN SHORE & BEACH PRESERVATION ASSOCIATION, annual meeting, Washington, D. C., April 19, and Jacksonville, Fla., April 21.

AMERICAN WATER WORKS ASSOCIATION, annual convention, Roosevelt Hotel, New Orleans, April 24-28.

REGIONAL AND LOCAL

NEW JERSEY MOSQUITO EXTERMINATION ASSOCIATION, annual meeting, Hotel Chalfonte-Haddon Hall, Atlantic City, March 23-25.

COUNTY ENGINEERS ASSOCIATION OF THE STATE OF CALIFORNIA, annual convention, U. S. Grant Hotel, San Diego, March 23-26.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, regional surveying and geodesy meeting, Rensselaer Polytechnic Institute, Troy, N. Y., March 24-26.

MICHIGAN SEWAGE WORKS ASSOCIATION, annual conference, Lansing, Mar. 30-April 1.

MICHIGAN ENGINEERING SOCIETY, annual meeting, Grand Rapids, April 7-9.

CALIFORNIA SEWAGE WORKS ASSOCIATION, annual spring conference, U. S. Grant Hotel, San Diego, April 11.

GREATER NEW YORK SAFETY COUNCIL, annual convention, Hotel Astor, New York City, April 19-21.

AMERICAN SOCIETY OF CIVIL ENGINEERS, Texas Section, spring meeting, Texas State Hotel, Houston, April 29-30.

MARYLAND-DELAWARE WATER AND SEWERAGE ASSOCIATION, annual conference, Emerson Hotel, Baltimore, May 19-20.

SECTION MEETINGS, American Water Works Association:
Ky.-Tenn., Louisville, March 21-23.
Canadian, Windsor, Ont., Mar. 23-25.
Illinois, Decatur, April 5-6.
Indiana, West Lafayette, April 7-8.
Pacific Northwest, Spokane, May 19-21.

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Examinations

IOWA: Examination for professional engineering, Mar. 22-23, and for land surveying, Mar. 24, Des Moines.